Sky and TELESCOPE

In This Issue

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The Editors Note . . .

COL. HANS CHRISTIAN ADAMSON is known to every American as one of those staunch companions of Capt. Eddie Rickenbacker during his recent experience on the Pacific. Not nearly so many persons know him as the originator and first editor of The SKY, one of this magazine's predecessors.

These thoughts occur to us on the occasion of Col. Adamson's Flag Day visit to the Boston Red Cross Blood Donors' Center, slightly preceding our own seventh visit there as donors.

Ex-editor Adamson was given just three or four hours to live when brought ashore, but a quarter of an hour later 13 life-saving units of blood plasma had been administered. "We were more than 1,000 miles from the nearest Navy base," Col. Adamson said. "The Marines had just moved in right under the nose of the Japs, but even way out there, the long arm of the Red Cross had reached out and placed the blood plasma where it was needed.

"Death does not wait," he continued; "it must be the blood plasma that is there waiting. You must give it before it is needed."

Boston's blood donors should contribute 6,000 pints a week, and other urban areas (33 blood donor centers in the United States) have similar large quotas to fill, **as ordered by the Surgeon General of the United States Army and Navy.**

Perhaps, as an amateur astronomer with some knowledge of the constellations, of navigation, or optics, you have wanted to help the war program—you may be doing so already. Giving your blood is not an astronomical pursuit, but it is a maximum contribution to winning the war, and there is no civilian (between the ages of 18 and 60) who is fully patriotic, even though working in the most vital war industry, unless he has done one of the following:

1. Donated his pint and planned to do so again every eight weeks.
2. Applied at the blood center for acceptance but been refused for one reason or another.
3. Decided to sign up to donate when the Red Cross mobile unit comes to his community.
4. Received from his doctor a statement that blood donation would not be desirable in his case.

And every story of the other fellow's experience in giving blood **must be ignored.** The apathy of most persons is usually cloaked by the excuse that so-and-so didn't feel so well afterward, or that he or she can't stand the sight of blood. Have you ever seen your own blood? Not just a pinprick's worth, but a whole pint? There's quite a difference —that whole pint is more like a scientific exhibit than a part of yourself, but you feel quite proud of it just the same.

Again, in Col. Adamson's words: "You give a man life itself when you give him a pint of blood."

Sky and TELESCOPE

In Focus

SKY SPECTACLES are celestial events which the layman can easily see and which arouse his interest in astronomy because of their beauty. This interest may lead, in turn, to the layman becoming an amateur astronomer, and, in a few cases, to his making valuable contributions to the science. As an amateur astronomer, my interest in sky spectacles dates back many years, coinciding also with my interest in still and motion-picture photography.

The front cover this month shows the crescent moon, Venus, and Jupiter, as they appeared in the western twilight at 9:05 p.m., Sunday, June 6th, forming a large triangle somewhat dimmed by the long summer twilight. Jupiter is nearest the horizon. On the original negative, earthshine is plainly visible on the dark side of the moon. The exposure was one second at f/8, on Eastman Super XX film, from a location along Southern State Parkway, Long Island.

These three objects are the brightest non-stellar members of the solar system, as we see them. Their triangular formation in the evening sky occurs about every 3¼ years; it happened previously in February, 1940, and is due again in September, 1946. It can easily be predicted on the condition that Jupiter be in the western sky, where it is at 13-month intervals, and that Venus be there also. But Venus' synodic period is 584 days, so its next return to the evening sky will find Jupiter in the east. Therefore, two synodic periods of Venus must elapse to bring about this situation once more. The moon is sure to pass the two planets before they get very far apart.

There are many other similar celestial events, such as aurorae, occultations, eclipses, close conjunctions, Mars' approaches, lunar phases, large sunspots, most of which justify photographic preparations at our Amateur Astronomers Association camera station at Oceanside. We seek to capture and reproduce the beauty of these spectacles for appreciation by everyone interested in the stars.

PETER A. LEAVENS

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Astronomers Meet at Cambridge

By Margaret Walton Mayall

Harvard College Observatory

IN SPITE of wartime conditions, more than 100 astronomers and their guests, from the United States and Canada, gathered at Harvard College Observatory over the weekend of May 28th - 30th, for the 70th meeting of the American Astronomical Society. If an award were to be given to the one who had traveled the greatest distance to the meeting, it would undoubtedly go to Dr. Andrew McKellar, of the Dominion Astrophysical Observatory, at Victoria, British Columbia. Like most other out-of-town astronomers, Dr. McKellar combined business with pleasure, by arranging a trip east to coincide with the A.A.S. meetings. Another Canadian visitor was Dr. Helen S. Hogg, of the David Dunlap Observatory, at Toronto, who spent several weeks prior to the meeting at the Harvard Observatory continuing her researches on the variables in some of the globular clusters.

The sessions opened Friday evening with a meeting of the teachers' conference, which has become a regular affair in connection with the meetings of the society. The first part of the program was devoted to the commemoration of the 400th anniversary of the death of the famous Polish astronomer, Nicholas Copernicus. The speaker was Dr. Joel Stebbins, president of the American Astronomical Society, who spoke on "Copernicus and Modern Revolutions." Dr. Stebbins said that among the many centennials astronomers celebrate, "the one date that seems to stand out above all others is 1543; this was the beginning, the zero epoch. We may not remember when Copernicus was born, but we do remember the date of the publication of *De Revolutionibus Orbium Coelestium*. The immortal life began at seventy for Copernicus."

Dr. Stebbins sketched the life of Copernicus, and the great importance of his revolutionary ideas; then continued: "We in our time have also been passing through a change just as revolutionary and perhaps as little noticed as when the Polish churchman quietly jolted us out of our fixed and privileged position at the center of the universe. Whereas for Copernicus the question was mainly whether the earth or the sun was at the center of the solar system, for us the questions have been whether the sun is near the center of the galaxy, how large is the galaxy, and are there other galaxies besides our own?" He closed by saying: "One hundred years hence there will be a quinquecentennial of Copernicus, and no matter how dark the present years and how crude our ideas become in retrospect, the name of Copernicus will continue to shine."

The latter half of the evening was spent discussing the problem of greatest interest to all astronomers who are teaching in connection with the war effort: navigation. Dr. Charles H. Smiley, of Ladd Observatory at Brown University, started the discussion with a talk on the problem of "Emergency Navigation with Limited Equipment."

Dr. Smiley assumed a man marooned on a liferaft with one scientific instrument—a watch which would keep fairly accurate time for 24 hours—and a table showing the times certain stars would be in the zenith for a few selected ports in all parts of the world. Thus, if the man were to set his course toward the selected star at the proper time each evening (four minutes earlier from night to night) he would eventually arrive at or near the desired port.

If the equipment of the liferaft included a table of the times of sunrise and sunset for different latitudes for various times of the year, the lifeboat mariner could also get his approximate latitude, provided, of course, that he could make accurate observations of the times of successive sunrise and sunset. Finally, if his watch told Greenwich time, he could estimate his longitude by the Greenwich time of local noon.

Thus, particularly for persons with no previous experience at navigation, and with the barest minimum of equipment, Dr. Smiley has developed two methods of emergency navigation; one is to tell where the liferaft is, and the other where it should try to go. A simple star chart, a world map, and elementary instructions constitute the total equipment, in addition to a few pages of tables.

In the discussion which followed Dr. Smiley's presentation, it was brought out that clear horizons in both morning and afternoon are often rare in many

Gathered in front of Building C are members and guests who attended the 70th meeting of the American Astronomical Society, May 28-30, 1943. Photo by the University Studio.

parts of the ocean. Dr. Smiley emphasized, however, that he was interested in real emergencies, where no time was available to gather instruments or tables of any kind, so the marooned persons would probably have only what the lifeboat provided and a watch or two which would still run. The comparison of these methods with those developed by Dr. Bart J. Bok, of Harvard, also for emergency navigation, was an interesting result of the discussion.

At the close of the teachers' conference, Dr. and Mrs. Harlow Shapley invited all the members and their guests into the Observatory Residence for an informal reception and get-together. Mrs. Shapley offered, as usual, her wonderful refreshments, including, of all things, coffee! (It is understood that the recent astronomical visit to Mexico helped save the coffee rations for the party.) Talking and eating continued far into the night.

The Cambridge dimout brought the war much closer to visitors from the Middle West, and darkened streets caused some to ask for guides back to their lodgings. After some difficulty, owing to the crowded conditions in Cambridge at this season, rooms had been found for everyone. Incidentally, the secretary had warned on his preliminary announcement:

"Advice to strangers in Cambridge (the voice of experience): don't try to take shortcuts via side streets; you'd be surprised what some of them do, and where they come out!"

At least one astronomer ignored this warning, and was known to walk from Harvard Square to Watertown, a distance of some four or five miles, instead of the one half mile to the observatory!

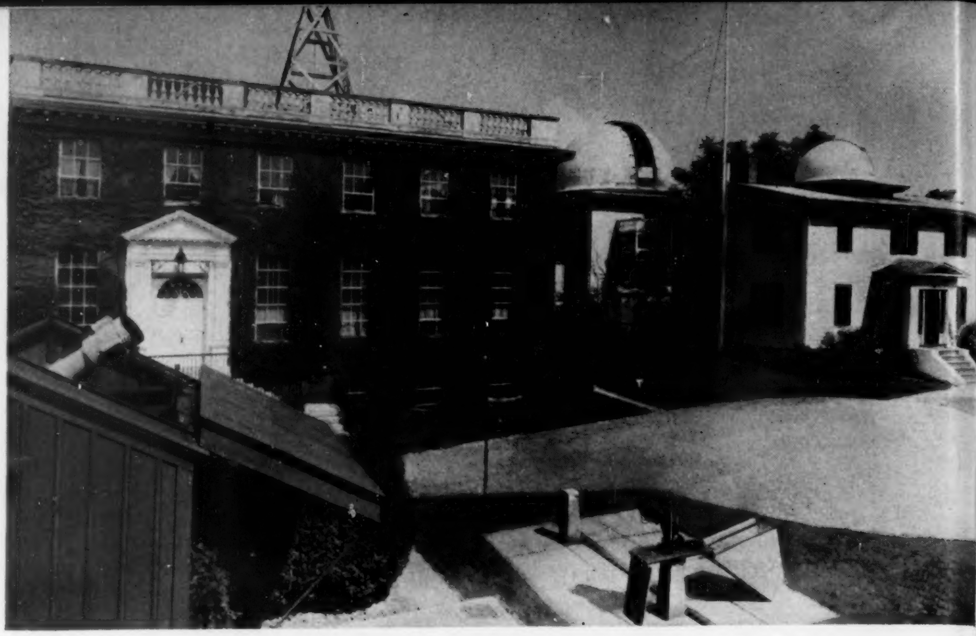
On Saturday, sessions for papers were held, both morning and afternoon. It was gratifying to note the variety and high quality of the many research problems still being worked on by astronomers. The papers presented included problems on variable stars, astrometry, spectroscopy, and infrared photography. (See page 12 of this issue.)

At the business meeting Saturday afternoon, Dr. Shapley was elected the new president of the society. Others elected are: vice-president, Robert R. McMath; secretary, Dean B. McLaughlin; treasurer, Keivin Burns; councilors, Harold D. Babcock, Dirk Brouwer, and J. J. Nassau; and member of the Division of Physical Sciences, National Research Council, Edwin P. Hubble.

Saturday evening everyone gathered at the Harvard Faculty Club for the society dinner. Arrangements had been made for 50 places, but by the time all had assembled, there were 104 hungry people. The club steward came to the fore nobly, and in spite of food shortages and rationing, fed us all very well. Of course, some tables had ham, some lamb, and still others duck and guinea hen, but each had that 1943 rarity, the potato!

The speaker of the evening was Miss Mary Collins, of the Harvard Geological Department, who introduced the astronomers to seismology and vulcanology. She spoke particularly of the new Mexican seismological station, and its strategic location near the famous volcano, Popocatepetl. She illustrated her talk with colored slides, and included photographs of the newly-born Mexican volcano at Paracutin, which now has a cone over 1,000 feet above the surrounding plateau.

The showing of beautiful Kodachrome slides of his 1942 astronomical trip to Mexico constituted Dr. Stebbins' closing contribution as retiring president of the society. He turned his office over to Dr. Shapley, who adjourned the meeting with an invitation to the society to return at some time in the future, perhaps in 1946, to help celebrate the 100th anniversary of the founding of Harvard College Observatory.



A general view of buildings and equipment at Harvard College Observatory, with the air-raid siren furnishing a very modern note. Photo by Robert Cox.

The Obsolete Tropic of Cancer

HIPPARCHUS, 2nd century B.C., the "Father of Astronomy," noted the precession of the equinoxes, which was known to Kidinnu, a Chaldean, two centuries earlier. One effect of this phenomenon is to cause the vernal and autumnal equinoxes (points where the sun appears to cross the celestial equator), to move slowly westward along the ecliptic, requiring about 26,000 years to make a complete revolution.

This great Greek astronomer was also a mathematician and a geographer. His contributions to science included the fundamental principles of trigonometry, and he invented the idea of co-ordinates on a sphere including terrestrial latitude and longitude.

During his century the vernal equinox was in the western part of the constellation Aries, so it was designated as the First of Aries (first in rising), and is sometimes known by that name even to the present day. That also fixed the summer solstice, the point farthest north in the sun's apparent annual motion, in Cancer; the autumnal equinox was in Libra; and the winter solstice in Capricornus, the sun's southernmost point.

At the time of the vernal equinox, March 21st, the sun shines perpendicularly at the earth's equator. Due to the 23½-degree inclination of the ecliptic to the equator, the sun shines perpendicularly on latitude 23½ degrees north at the time of the summer solstice and perpendicularly on latitude 23½ degrees south at the time of the winter solstice. These latitudes limit the torrid zone to a width of 47 degrees.

And now we come to the zonal boundaries on the earth's surface known as the Tropic of Cancer and the Tropic of Capricorn, which sound astronomical as well as geographical. They were so designated 2,000 years ago, because at that time the sun was in those zodiacal constellations when it was farthest north and farthest south, respectively.

But approximately 1/12 of the period of precession has passed and conditions have changed. Due to that phenomenon the vernal equinox has moved westward among the stars about 30 degrees, so the sun is now in Pisces at the time of the vernal equinox, in Gemini when it is farthest north, in Virgo at the autumnal equinox, and in Sagittarius when it is farthest south. So the Tropic of Cancer at present might more appropriately be called the Tropic of Gemini and the Tropic of Capricorn is more appropriately the Tropic of Sagittarius.

W. CARL RUFUS
University of Michigan Observatory

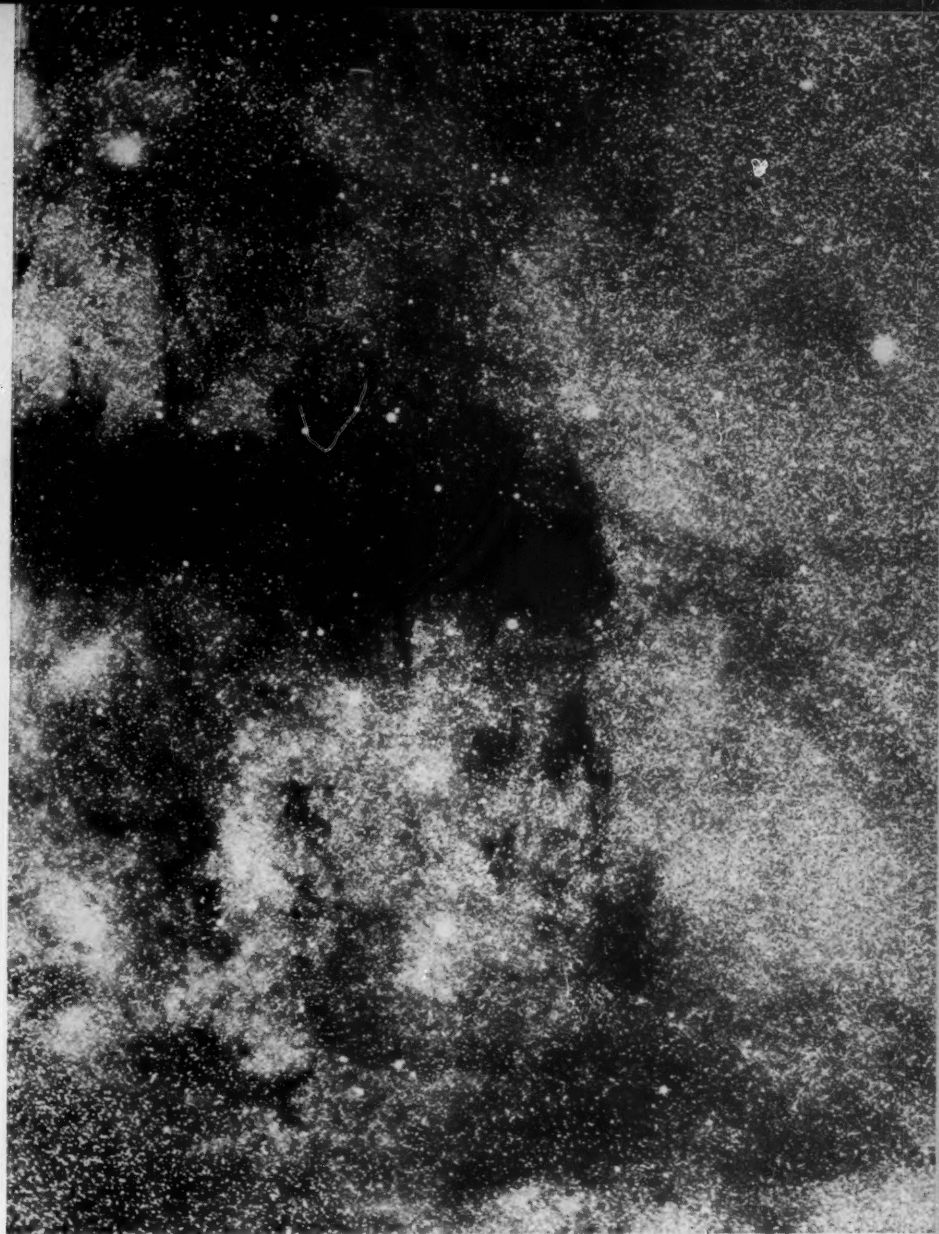
Problems of Stellar Evolution

By Cecilia Payne Gaposchkin
Harvard College Observatory

THE evolution of stars—to talk of it, even to think of it, must sound presumptuous. How can a man, from his tiny toehold in space, his twinkling of an eye in time, dare to speak of the evolution of the "eternal stars"? But that is the privilege of the scientific man—to generalize from a tiny sample. A poet puts it better:

To see a world in a grain of sand,
And a heaven in a wild flower;
Hold infinity in the palm of your hand
And eternity in an hour.

Evolution—what does an astronomer mean by the word? About 100 years ago the thinking world began to accept the idea of biological evolution. It was recognized that the types of living things that had existed in successive ages had undergone change, and it was believed that there are probably family relationships and broad lines of descent that can be traced from one age to another. Other sciences, besides biology, caught the idea.



The great dark clouds of dust in the Milky Way are composed of the material from which stars are born. Photograph by E. E. Barnard.

Of course, it is absurd to look for evolution, in the biological sense, among the stars. The development of living things can be traced because we possess evidence from many generations, not only through recorded time, for several thousand years, but down through the fossil record, for several million. But there is no fossil record for the stars. So far as we can tell, all the stars belong to the *same* generation, and that the first. If the stars had any immediate parents, they were certainly not *stellar*.

To understand the astronomical basis for the idea of stellar evolution, let us for a moment take a mosquito's-eye view of the human race. Let us suppose a scientifically inclined summer mosquito were to give an account of the race. He would describe us as being of various sizes, some of us small and helpless, some larger and more able to defend ourselves, some full-sized. He might note various degrees of activity and types of behavior, corresponding to babies and children, mature, middle-aged and old people. But his own life (compared to the human span) is very short—let us give him a couple of days. What chance is there that he would be able to form any true notion of human development? He might be able to arrange his subjects in the correct *order,* but he would have no way of knowing whether mankind originates in old age or in babyhood.

The mosquito's-eye view of the human race is about equivalent to an astronomer's-eye view of the stars. We know that there are large and small stars, hot and cool stars, single stars and gregarious stars. But our life span of 70 years, even the life span of astronomy, a couple of thousand years, has not been long enough to witness appreciable changes in the stars.

We cannot tell from their looks which are the old stars and which the young ones. But all the same we are bold enough to think that we know. The more recklessly and prodigally the star is expending its energy (in other words the more brightly it shines, which it does in proportion to its mass), the younger do we suppose it to be. Well-known examples of such young stars are the red Betelgeuse and Antares.

Mature stars behave with more restraint. The sun, for example, is a middle-aged star that has adapted its expenditures to a moderate standard of living, in spite of its conversion of 4,200,000 tons of its mass into radiant energy each second.

And to see the very old stars, we must turn to those curious, faint ones that are eking out existence with the slow expenditure of their small remaining resources, enlivening the passing millenia with an occasional spasmodic flare. By a curious accident, it happens that the so-called novae or "new stars," which go up in a sudden burst of brilliance, are really very old stars going through one of their outbursts of waning energy.

The division of stars into young, middle-aged and old rests on the simplest of reasoning. These conclusions are drawn from the rate at which the stars are using up their supply of food. It is not possible for a star of given mass to store up within itself more than

a given amount of food, so from a star's mass we know how much food it can store. We know, too, how much food the stars are using, for those which are using their food supply at the greatest rate shine most brightly. The giant stars are shining so brilliantly that it is easy to calculate that their supply of food cannot last them very long at this rate—and also, that they have not been drawing upon their food supply for very long or they would have used it up already and have ceased to shine.

A few years ago it would have been usual to conclude the preceding sentence with the words: "which is absurd." It was found that these very bright stars—the giants and supergiants—could not even be as old as the earth, and the general opinion was that a picture that called for the continuous creation of young stars, to replace the old ones that had eaten themselves out of existence, was untenable. But this is one of the problems that have been solved—or, at least, it is in the process of solution.

We have never witnessed the birth of a star. Cosmic processes are so slow that even stellar formation must last for millenia. But we can see the pre-stellar material, stuff just ready to form into stars. We think we know how it turns into stars; and we can point to stars that must be very newly born indeed. The companion of Epsilon Aurigae is one such.

Even with unaided eyes you can see the pre-stellar material. Glance up at the Milky Way some moonless night, and look at its great dark rift that runs from Cygnus down to Ophiuchus. Look farther south at the broken clouds of Sagittarius, where the center of the disk that makes up our Milky Way galaxy is situated. That is not really a rift in the Milky Way. On the contrary, it is a great cloud that hangs between the stars and cuts off the light of those that lie beyond it. Probably half of the material in our system is in the form of such clouds, not stars.

These clouds are, for the most part, made of a sort of dust. A few large lumps there must be, a number of individual atoms there certainly are, but a great part of the stuff of the universe that is not stars is simply dust. And from the dust we now believe that the young stars are made. The clouds are pushed and pulled by the pressure of light and the pull of gravitation, and when conditions are just right—they have to be precisely right—the dust is formed into stars.

The process is enormously slow. The birth of a star in this way takes millions of years. Even after birth the stars bear for some time the marks of their origin. On the surfaces of the very youngest stars, the gigantic red stars (of spectral class *M*), the long-period and irregular variables, can still be seen the remains of the churning, swirling motions of the parent clouds of dust. The direct evidence for this is found in the irregularities in their fluctuations of brightness.

I have described the passing of a milestone in the study of stellar development, a passing we owe principally to the efforts of Dr. Lyman Spitzer, Jr., of Yale University, and Dr. Fred L. Whipple, of Harvard. We believe now, thanks to these men, that we know how the stars may be born, how the stellar population is maintained. Another milestone was passed a short while back, thanks to Dr. Hans A. Bethe, of Cornell University, and to scores of atomic physicists—this one marks our first definite understanding of how the stars are fed.

The digestive processes of the stars are a good deal simpler than our own. Their diet is simpler. We depend on organic compounds for nutrition; the stars feed upon raw atoms. In a general way this has been obvious for a long time, but only recently have the actual items of the diet been recognized, the details of the digestion followed and described, if not fully understood.

The food of the stars is hydrogen, lightest of the chemical elements, and simplest in structure. The sun feeds on hydrogen, digesting it by a rather complicated interplay of the atoms of carbon, nitrogen, and oxygen in its interior. (Oddly enough, these are the very same elements that are of first importance in our own nutrition.) The carbon plays an especially important part, for it furnishes the means of keeping the process continually going, and it is not consumed, or rather, it is continually re-created.

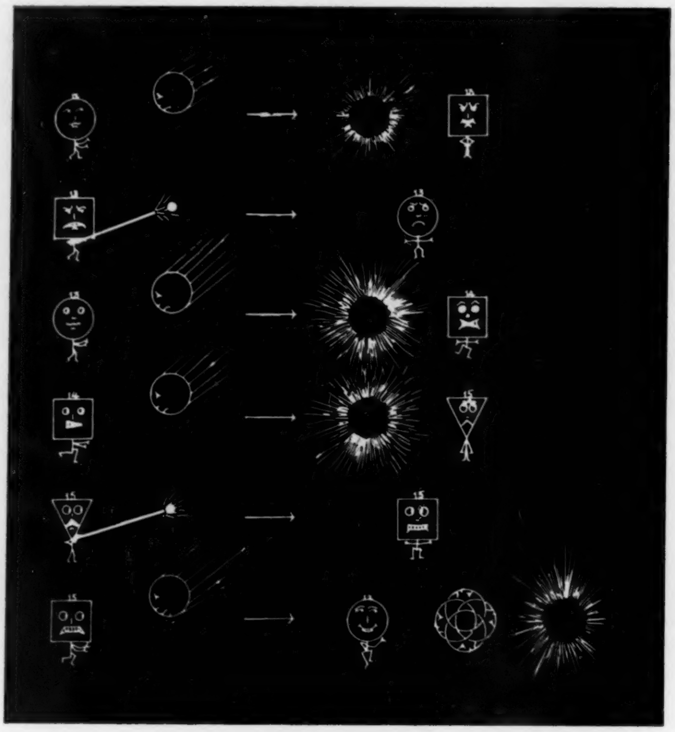
Ordinary carbon has an atomic weight of 12 (more precisely, its nucleus alone weighs 12.00068); in our imaginative diagram of a 6-act playlet it is the first actor in the drama of keeping the sun shining. The opening act finds a hydrogen nucleus (weight 1.00758), usually called a proton, flying swiftly toward the carbon nucleus and combining with it to form nitrogen of atomic weight about 13. There is a slight loss of mass which appears in the form of radiation—a quantum of gamma rays bursts forth—the first energy emission in the cycle.

The second act is a soliloquy by a very sad actor, nitrogen 13. He is unhappy until he has rid himself of what is to him excess electricity in the form of a positive electron or positron. In this way he reverts to carbon once more, but this time his atomic weight is 13 instead of 12.

(Off stage, the positive electron has a very short life, because he shortly encounters an ordinary negative electron—they combine to produce a photon or bundle of light energy. At the high temperature inside the sun, collisions between atomic particles are so continual and powerful that most of the atoms have lost their ring electrons. The sun's interior is thus populated by countless free electrons, bare atomic nuclei, and powerful radiation.)

In the third act, another proton strikes carbon 13 and turns him into nitrogen once more, this time of the usual form, atomic weight about 14. And again a burst of gamma radiation takes place.

The new nitrogen is satisfied with life—he is a stable atom—but nevertheless he is pleased to collide with an-



The carbon cycle playlet, with carbon 12 the first actor on the scene (top line, left). Hydrogen nuclei are the fast-flying fellows taking part in acts 1, 3, 4, and 6. In the same acts, gamma-ray bursts appear, while in acts 2 and 5, positrons are ejected. In the last line, representing act 6, the rejuvenated carbon returns to the scene, along with a helium nucleus of atomic weight about 4.

other fast-flying hydrogen nucleus and to turn into oxygen 15. But this is the sad cousin of nitrogen 13, and in the fifth act he too disposes of a positron as soon as he can, reverting to nitrogen of atomic weight 15.

The final act begins as have several of the others, with the entrance of a proton on the scene, but the grand climax is a real surprise. The expected ending is the formation of oxygen of normal weight 16.00000, but while this is the end-product on rare occasions, the usual result is two complete atomic nuclei, one of helium of atomic weight about 4 and the other the original carbon 12!

During this drama, four hydrogen nuclei of total atomic weight 4.03032 have been used up. Four bursts of gamma radiation have taken place, and two brief-lived positrons have been produced. The carbon has returned to its original state and the helium is the end-product, itself immune to the bombardment of other protons like its parents. But the helium nucleus weighs 4.00276, or 0.02756 less than the total of the four hydrogen nuclei from which it was formed. Of this, 0.00110 was released as positive electrons and the remainder as gamma radiation, the energy of which can be computed from the familiar relativity equation: $E = mc^2$, where m is the mass of the matter converted and c the velocity of light in a vacuum. The total energy released in each carbon cycle is exactly 40 microergs, which gives the sun energy to shine for some 30 billion years, at least.

This solar digestive process, the *carbon cycle,* depends for its operation on the conditions within the sun, particularly the temperature. And the middle-aged sun, in common with the vast majority of stars—those of the main sequence—has an internal temperature within the range of 20 to 30 million degrees, just right for the process to go on. However, as the rate of the carbon cycle increases with the 16th or 17th power of the temperature, stars with slightly hotter interiors than the sun's may shine much more brilliantly. The star Y Cygni, a hot blue giant, has a mass about 17 times as great as the sun and shines 10,000 times as brightly, but its central temperature of 33 million degrees increases the carbon cycle generation about 6,000 times, so the higher rate of radiation is accounted for satisfactorily.

But the giant stars, the infants of the stellar system, are a different case. They are not so hot within—their temperatures are between 10 million and one million degrees, sometimes even less. *They* cannot be nourished by the carbon cycle. Food for the infant stars is to be found among the light atoms, lithium, beryllium, and boron, which are consumed at the lower temperatures, with the production of energy enough to keep the stellar babies going.

Lithium, beryllium, boron—unfamiliar names! Unfamiliar, compared to carbon, nitrogen, oxygen, that maintain the sun. And with good reason. The youthful stars must consume all these light atoms before they arrive at the stage where the sun is now. And the sun, like other middle-aged stars, has only a little of the stellar baby food left. In the primitive universe these light atoms must have been very common indeed. But on the earth, perhaps born from the sun long after the solar infancy, they are rather rare.

Deuterium, or heavy hydrogen, is probably a star's first food, its combination with ordinary hydrogen taking place at about 300,000 - 400,000 degrees internal temperature. But stars feeding on deuterium probably are too faint to be visible. After the deuterium is exhausted, the young giant contracts until its interior reaches two million degrees, when the lithium begins to combine with the hydrogen in the reaction: $Li^7 + H^1 = 2He^4$, and energy is released to help the star shine. At three million degrees beryllium is transformed, while boron requires a temperature of five million degrees for one isotope and nine million for the other. But there is no return to the original atom, as in the case of carbon, so we cannot call these transformations cycles. The lighter elements are indeed the food for the young stars, but they are exhausted long before the hydrogen, which is practically the only available fuel remaining when the carbon cycle sets in. The sun is about 35 per cent hydrogen, so the great abundance of this element prolongs the middle period of a star's life enormously in proportion to its youth.

Two milestones have been passed: the knowledge of how the stars are fed, and the idea of how the stars are born. There are several more milestones ahead—several unsolved problems near enough to solution to be stated. One of these concerns the *origin* of the food of the stars. It is very remarkable that the universe contains not only light atoms, such as hydrogen, oxygen, and carbon, but also heavier ones, such as iron, and some very heavy ones, like gold and lead. When I was describing the digestive process of the sun, I had occasion to mention only light atoms. No others could have been mentioned, for it is definitely not possible, inside any star we know of, to produce any atoms heavier than neon, which is only number 10 in a list of 92 elements. In other words, the chemical elements were not formed within the stars. They must have been made before the stars were made. But how, under what conditions, and where?

These are far-reaching questions, and they are tied up with the greater problem of the history of the universe. We cannot discuss the evolution of stars without becoming involved in the evolution of the atom on the one hand and the evolution of the cosmos on the other.

The history of the cosmos is an unsolved problem of the first magnitude, and only a few general lines of thought run clearly. In order to produce the atoms as we know them it is necessary to suppose that the universe had at one time a temperature (or its equivalent) of billions, rather than millions, of degrees—a thing imagination boggles at, but good astrophysical theory, just the same. And the raw materials of the cosmos must have had a very different distribution in space from what we observe nowadays.

When this process or these processes (for there seems to have been more than one) can have taken place, or where, are problems that are unsolved, probably unsolvable. The space factor is introduced by having to account for the distributions, compositions, and motions of the large-scale aggregations of the universe—galaxies and supergalaxies. And the variety of atoms introduces the temperature factor. The origin of the

(*Continued on page 19*)

ASTRONOMERS

I read of how their cameras plumbed the sky
For maps new generations might compare
With later charts, whose tracery would declare
What needle's width the stars had seemed to fly.
Even while nations crumble, kingdoms die,
Towns burn, and continental battles flare,
These priests, from their domed temples high in air,
Reach out through time to watch the suns roll by.

A sense of more serene, abiding things
After the sad world's fury, touched my heart;
For still the eternal systems would rotate,
And man, though earth-bound, still would soar on wings,
Since the star-searcher's passionless gaze could dart
Long years beyond our terror, pain and hate.

STANTON A. COBLENTZ

Reprinted from *The Christian Century.*

Summer Stars

By William H. Barton, Jr.

July is the month for summer stargazing, whether you choose the cool of the evening in the country or the coolness of the Hayden Planetarium chamber, where constellation study is on schedule this month.

That bright star about halfway up the eastern sky at 9 o'clock war time during early July is Paris. Just to the northwest you will see Prague while toward the southwest is Belgrade. Brussels and Amsterdam shine brightly. These are all stars in the constellation Europe Regained. Toward the northeast and low in the sky China shines brightly. In this group you will find Confucius and Chiang Kai-shek. Low in the southeast the Painter is rising, followed soon by the Story Teller. Then there is Science and the Music Maker, the Airman and the Poet.

You may have trouble finding these stars and constellations on your star charts. But that is because you are using out-of-date guides with names that date back hundreds of years. That has all been changed now, at least, it would be if a suggestion made by A. P. Herbert were adopted. Perhaps, then, future generations will be wondering who Mollison was, and Clipper. Clipper is not a "who"; it is a "what." But maybe they won't know that. For details see the article in *Sky and Telescope* for April, "An Englishman Renames the Stars."

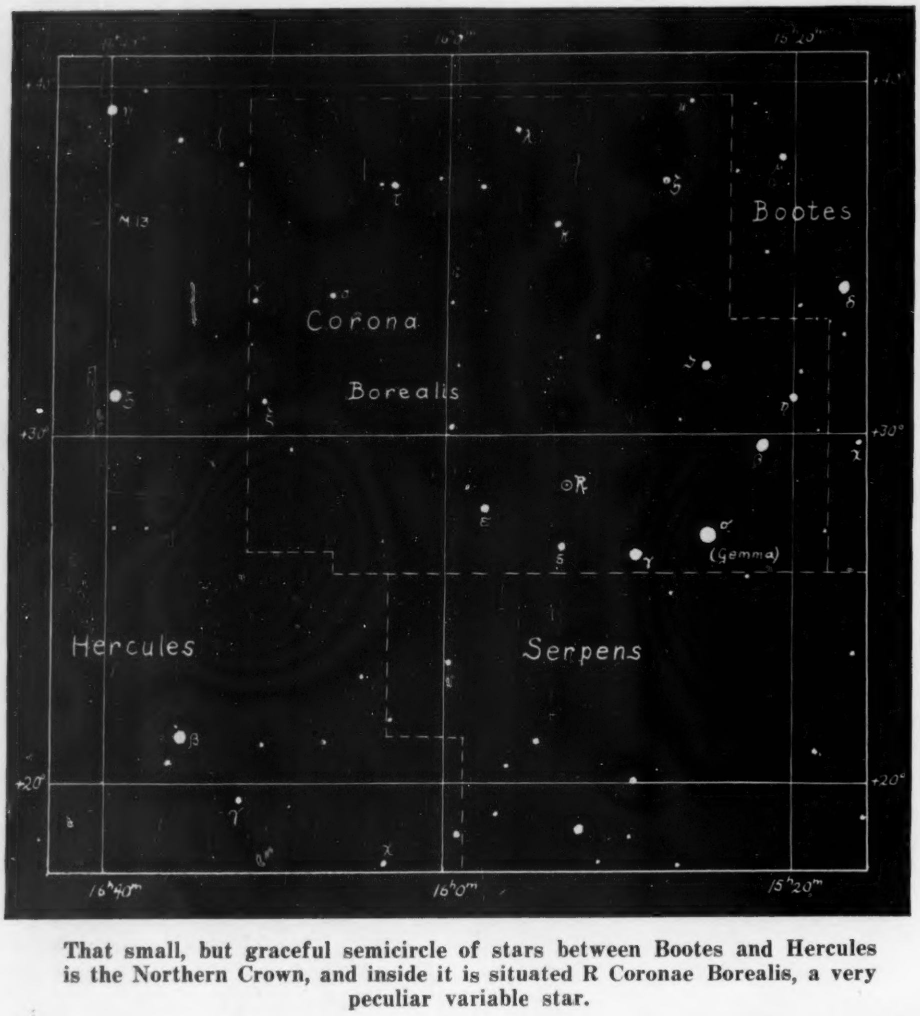
The star that Mr. Herbert calls Paris is our old friend, Vega. This, the brightest star of the summer sky, has had many names. The name first appeared in the Alphonsine Tables as Wega, derived from the Arabic Waki. Bayer used both names. Scaliger called it Waghi, and Riccioli, Vuega *vel* Vagieh. In the 16th-century almagests and tables it was Allore, Alahore, and Alohore, from the Greek. Among Latin writers it was Lyra (our name for the constellation in which it is found). It has been identified in Babylonian astronomy with Dilgan, messenger of light.

The Romans held it as an important star. Their autumn began when Vega set in the dawn. It was the pole star some 14,000 years ago and will occupy that important place in the sky 12,000 years from now. At best, however, it is 4½ degrees from the pole compared to one degree for our present Polaris. It is also near the spot toward which the sun is rushing—carrying the planets along at 12 miles per second. It was the first star to be photographed; on July 17, 1850, a daguerreotype was made at Harvard College Observatory.

In Herbert's astronomical new deal, Vega is in a constellation with stars borrowed from Hercules and Draco. This is not the first attempt to shake up the constellations. Giordano Bruno, in the 16th century, wanted to substitute the moral virtues for the old constellation names. He listed Law, Mercy, Prudence, Truth, Universal Judgment, Wisdom, and so on. A half dozen or so reformers in the 17th century proposed Biblical names, and coats of arms of the reigning houses. In the last century, a Miss Frances Rolleston and the Reverend Doctor Seiss had their ideas, and even Proctor made proposals along the same line. But we always drift back to the old names. I doubt that it is any more difficult to learn the name "Vega" than it is to learn "Paris."

Aquila, the Eagle, along with Delphinus, the Dolphin, becomes the Music Maker. Whereas we now name but five stars in Aquila (most people know only one, Altair) and two in Delphinus (most sky students do not know either), the new arrangement lists 15. Of all these only Altair is bright enough to receive recognition in the main *Air* or *Nautical Almanac* lists, and one, a 3rd-magnitude star, is in the list of additional stars.

How about looking for a few of the more difficult things in this July sky? Almost in the zenith, just a little to the southeast, is the circlet of stars that we call the Northern Crown, Corona Borealis. You can plainly see seven stars in the group and you will notice that one is much brighter than the others. This is generally called Gemma, the Gem, but to the navigator it is Alphecca. This name comes from Ulugh Beg's Al Na'ir al Fakkah. Al Na'ir indicates the bright star, somewhat equivalent to the old term "lucida" that appears in many books of past generations. Al Fakkah is "the dish." In many ancient sources Corona was called a bowl, dish, or platter. This group has been a favorite with sky watchers for centuries. Argelander listed 27 stars here visible to the naked eye and Heis, 31. Large telescopes photograph thousands of galaxies in Corona. Have you counted those pictured on the back cover of *Sky and Telescope* last month (more galaxies than stars)?



That small, but graceful semicircle of stars between Bootes and Hercules is the Northern Crown, and inside it is situated R Coronae Borealis, a very peculiar variable star.

The famous North America nebula is one of the wonders of summer skies. It is located in the Milky Way close to Deneb, but shows well only on long-exposure photographs. Amateurs with richest-field telescopes may glimpse it under perfect conditions. Photograph by Barnard.

In the neighboring constellation to the east, Hercules, look for several obscure objects. The stars can be made to form an H, or K (backward), or a butterfly, or a keystone if you use the northern wing of the butterfly. There are no outstanding stars in this group, but along the western edge of the Keystone, the side toward Corona, you may catch sight of a dim, hazy spot. It is almost a third of the way from the northern star to the southern. (The line between these two stars points almost to the north pole.) The object we are referring to is the cluster in Hercules, also known as M13. It is a globular cluster, composed of probably 100,000 members. The cluster is about 33,000 light-years distant. Through the telescope, or better on photographs (see the back cover this month), there is a dense central part of about 15 light-years diameter, while the outer portions are fully 100 light-years across. It is estimated that the nucleus may contain 1,500 times as many stars as the same volume of space in our own neighborhood. There are less than 100 of these globular clusters in the entire sky.

If you have trouble seeing this hazy spot try averted vision, or peripheral vision, as it is sometimes called. Great attention is now being paid to testing and training night lookouts for maritime service. Spotting a dim ship in the night is not unlike spotting a dim celestial object in the night sky. Astronomers have always practiced adaptation and averted vision. The fact is that the central part of the eye's retina is sensitive to color and detail, but the outer portions are far keener in a dim light. The central part may be blind in dim light and the periphery still sensitive. Then, too, we see moving objects more easily than still objects. Motion is relative—if the object won't move, you can move your eye. So if you shift your eyes quickly on a region off to the side, you may out of the "corner of your eye" catch sight of those dim objects that are otherwise invisible. These principles are finding important applications in wartime activities, both military and civilian.

Just northeast of Hercules is the constellation Lyra, with Vega as its brightest object. Near Vega, you will see two rather dim stars making with the bright one a small equal-sided triangle. The northern one is Epsilon Lyrae. It can really be seen as two stars by those with keen eyesight, or perhaps as an elongated star by those of lesser sight. These two stars are 207 seconds of arc apart. Try your averted vision on the pair, and then remember that the perturbation of Uranus on which Neptune's place was calculated was 128 seconds, a little over half of the distance that you may be able to see. Such is the way of astronomy.

Through a telescope, of course, the two stars are widely separated. An opera glass will set them apart, and a good 3-inch telescope will reveal something further under good conditions. These two stars are each pairs of stars about three seconds apart. Epsilon Lyrae is the famous double double. This fact was first published in 1779 by Father Christian Mayer of the Jesuits. However, it is generally believed that Sir William Herschel had discovered the quadruple star previously.

In these days of "navigation for everybody," measuring rods in the sky are important. How much is three degrees or seven degrees or 18 degrees? That little triangle made by Vega, Epsilon, and Zeta Lyrae is just two degrees on a side. The distance between Deneb and the star at the middle of the Northern Cross (Sadr) is 6½ degrees, whereas the Great Square of Pegasus, just rising in the east, is about 15 degrees on its long side. (The Square is not a square square!) These are a few yardsticks to keep in your navigation tool chest.

NEWS NOTES

By Dorrit Hoffleit

AN ELUCIDATION

Last month in a Note on "Patchy Interstellar Clouds" we commented to the effect that interstellar lines are not a good criterion for stellar distances. Dr. Paul W. Merrill, of Mt. Wilson Observatory, kindly points out that our statement was "too sweeping," and should be qualified by adding the words "from the *molecular* lines." We quote him further: "Extensive observational material shows a pretty good statistical relationship between stellar distance and intensity of the interstellar lines H, K, D1 and D2 [lines arising from calcium and sodium *atoms*]. Mr. Adams' results tend to confirm rather than to upset this relationship. They do show of course (what we knew before) that distances determined by present methods from intensities of interstellar lines are not very precise. The new data are of fundamental importance in extending our knowledge of the structure of interstellar clouds; they may lead eventually to more accurate distances."

MEMORIAL TO DR. J. S. PLASKETT

During his lifetime, Dr. John S. Plaskett, first director (1917-1935) of the Dominion Astrophysical Observatory, Victoria, B.C., was awarded many medals for his astronomical achievements. He was also intensely interested in religious matters, and played a prominent part in the activities of St. John's parish church in Victoria. The *Journal* of the Royal Astronomical Society of Canada notes that three beautiful windows have been placed in that church by Mrs. Plaskett and her sons, Stuart and Harry (the director of the Observatory of the University of Oxford). The funds for the windows were raised mainly by melting down Dr. Plaskett's gold medals, symbolically fusing his two celestial interests.

ASTRONOMERS AND THE WAR

Along with the preliminary announcement of the meeting of the American Astronomical Society, the secretary, Dr. Dean B. McLaughlin, sent out requests to astronomers in the armed services and in war work to give an account of themselves to the extent that imposed secrecy would allow. Before the meeting he had received replies from seven individuals and the following note signed by 18 astronomers working on a project in Pasadena: "The undersigned make up a local cluster of astronomers, some globular, some not."

From these reports and others it appears that the Navy is more popular with astronomers than the Army, although Col. Philip Fox and Major T. E. Sterne prove there are astronomers who are enthusiastic soldiers. One lieutenant commander is in charge of certain mine-sweeping operations; at least two lieutenants are teaching at Annapolis; others are in Washington or Newport and one recently had Midway Island as his address. Two young men are flight lieutenants in the Royal Canadian Air Force, one of them serving overseas. At least one woman astronomer is a WAVE. Many others, both men and women, are in civilian non-astronomical jobs. And to these are to be added all the professors and teachers whose classes have become almost entirely navigation.

EUROPEAN PUBLICATIONS

The Committee for the Continued Distribution of Astronomical Literature has recently obtained a group of publications representing investigations at Dutch, Swedish, and German observatories. Five numbers of the *Bulletin* of the Astronomical Institute of the Netherlands contain about 20 papers issued June 29 - September 5, 1942. Twelve are by the Danish director of the Leiden Observatory, Ejnar Hertzsprung, many dealing with unusual eclipsing variables; others, with the convergence point of the Hyades moving cluster, measurements of double stars photographed at the Union Observatory at Johannesburg, South Africa, and star colors.

Other contributions from the Leiden Observatory constitute a catalogue of 798 faint zodiacal stars and observations of minor planets, both known and new. J. H. Oort (peacetime secretary of the International Astronomical Union) and his collaborators present a series of valuable papers dealing with our galactic system: the distance of the sun above the galactic plane, the position of the pole of the system determined from many varieties of material (clusters, Cepheid variables, high-velocity stars, high-luminosity *O* and *B* stars) giving satisfactorily accordant results. Their investigation of the distribution of the long-period variables leads Oort and van Tulder to believe that only one fourth of the total number of this class of stars with apparent magnitudes between 9 and 10 have yet been discovered. On the average, these stars are more than 400 times as luminous as our sun. A large 75-page paper by A. Pannekoek, of the University of Amsterdam, investigates the dark nebulae. From this array of papers, it is apparent that the Dutch have been valiantly carrying on astronomy, even during the occupation.

Investigations published by Stockholm astronomers within the past year include papers by Lindblad and Ohman on the direction of rotation of the spiral nebulae, in which they still reach conclusions contradictory to those found by Hubble (see "News Notes" last month); papers by Alfvén on the cosmogony of the solar system; and a note by Grönstrand on the cyanogen spectral criterion for determining absolute magnitudes.

The German astronomical papers, published 1939-42, coming via Zurich, also show a diversity of topics. A prettily printed booklet by Ernst Zinner, *Der Sternenmantel Kaiser Heinrich's* (the astronomically decorated coronation robe worn by Kaiser Henry II in 1014), is of minor interest to astronomers: its main purpose seems to be to call attention to attractive astronomical antiques in the Heimatsmuseum of the town of Bamberg. The other papers received are of a more serious and valuable nature. Three by Director Guthnick, of the Berlin-Babelsberg Observatory, deal with the very complex variable star, V 389 Cygni. There are two technical astrophysical papers, one by Unsold being a discussion and extension of some of Eddington's work.

Two astronomy books have also been published in Germany in 1942. One of 100 pages on cosmological theories, by O. Heckmann of Hamburg-Bergedorf, looks too technical for the amateur. The other, *Sterne und Sternsysteme,* by Wilhelm Becker (formerly of Potsdam, now apparently at Vienna) aims to fill the need for a general text intermediate between the popular and purely technical works. On hasty examination it appears to fulfill its purpose admirably and should serve the German student much as the famous "Russell-Dugan-and-Stewart" does us. The student will appreciate its up-to-date informativeness; the professional, its numerous references to original sources. It is well printed on good quality paper (but is in paper covers).

All in all, we feel sure that European astronomers could, other conditions permitting, have at least as fine a session for papers as we did at the American Astronomical Society meeting in May.

ASTRONOMER SCARES SHARK

Recently Dr. P. van de Kamp, of Sproul Observatory, had a letter from his former assistant, Lt. Armstrong Thomas, U.S.N.R., who, we suspect, is still somewhere in the Pacific. He writes, "I swam into a shark the other day. I saw something swimming under water, put on my diving mask and saw the shark about five feet from me. I was not alarmed because he was only about five feet long and he had a most peaceful and contented expression on his face. He swam away and, although I dived quite a bit looking for him, he never again appeared." Maybe the shark was looking only for Japs, too.

BEGINNER'S PAGE

By Percy W. Witherell

"Oh, Be A Fine Girl, Kiss Me Right Now, Sweet"

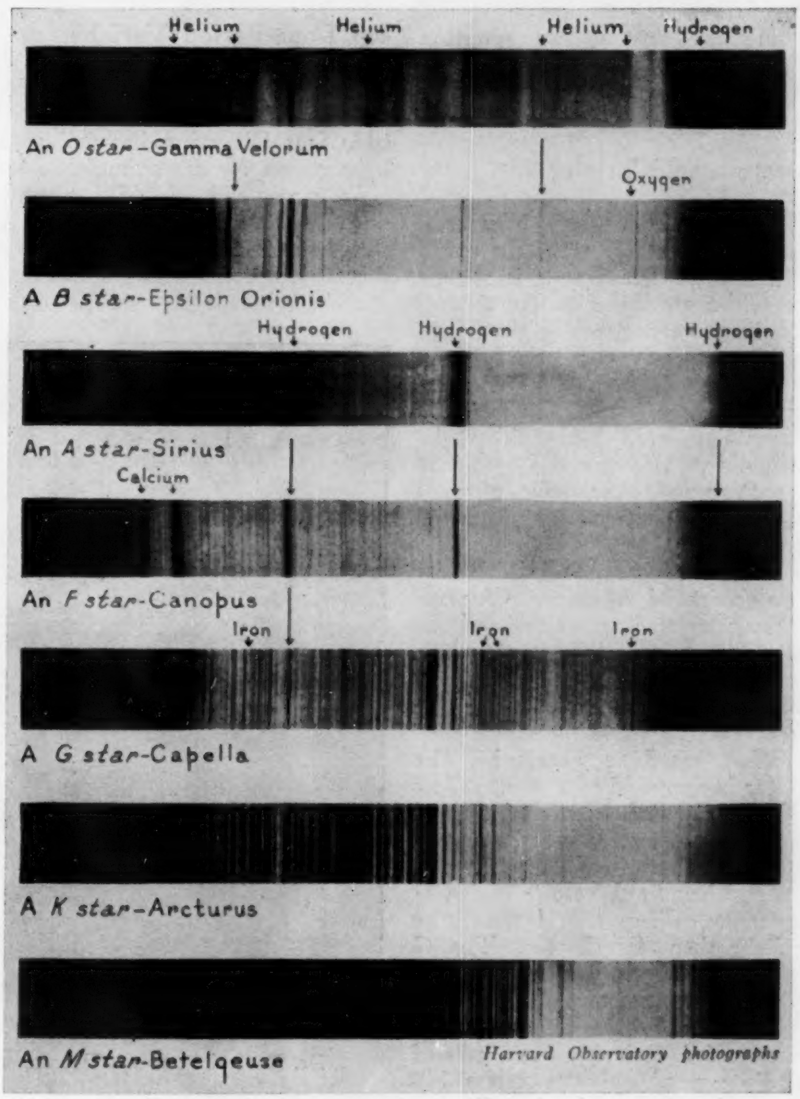
Other Boys Are Faster George,

THIS romantic request that describes for the astronomer the order of spectral classification of the stars reminds us that humor is usually enjoyed by the serious thinker. Originally, the classes were designated in order from A to N, but more detailed knowledge showed some as unnecessary, and the six principal classes: *B*, *A*, *F*, *G*, *K*, *M*, were further divided into decimal subclasses, *B*0 to *B*9, *A*0 to *A*9, and so forth.

You may recall that Newton allowed a beam of white light to pass through a slit and then through a prism, thereby producing a spectrum. He then recombined the separate colors by passing them through another prism to obtain white light again. This proved that white light is made up of many different colors of different wave lengths.

Light rays change direction as they pass obliquely from one medium to another of different density, so as they go from the air into the glass of a prism and then out into the air again, the rays of shorter wave length, at the violet end of the visual spectrum, are refracted (bent) more than the longer rays at the red end. This separates the wave lengths (colors) into a spectrum.

There are three kinds of spectra: 1. If a solid, or a liquid, or a dense gas is heated to incandescence, its light makes a *continuous* bright spectrum containing all the colors. 2. An incandescent rarefied gas gives a spectrum of bright *emission* lines on a dark background. These lines are pictures (images) of the slit of the spectroscope as reproduced by the particular wave lengths of the light that is given off by the gas under observation. The positions and colors of these lines are always the same for any one element radiating under the same conditions. 3. Now, if light from a hot solid, liquid, or dense gas passes through a cooler gas of low density, the latter absorbs the vibrations which correspond to its own bright emission lines, thereby producing blanks in the light transmitted. These blanks appear as dark lines on the continuous spectrum, which is then called an *absorption* spectrum.



Typical stellar spectra, with the violet at the left. The absence of light of short wave length is very noticeable in class M.

Comparison of the emission or absorption lines in any spectrum with the lines of the spectra of known elements in a laboratory source makes possible chemical analysis of light from any source, and elements are often identified when only minute amounts are included in the material being tested.

Most stars have absorption spectra—we visualize an ordinary star as having an *interior* whose outer boundary or surface is an opaque *photosphere* from which the continuous spectrum originates, and an *atmosphere*, where gases at comparatively low temperatures and pressures produce absorption lines in the continuous spectrum.

Temperature is the chief factor in determining what lines will show in a star's spectrum. Density and abundance of elements are of secondary importance. Nevertheless, hydrogen is so abundant that its absorption lines appear in all classes, beginning in *O*, growing stronger through *B* to a maximum in *A*, and gradually fading in the later classes. Helium shows in the *O* and *B* stars, but not later than *B*9. In class *A*, lines of calcium, sodium, and iron appear, becoming more prominent, along with other metals, through *F*, *G*, and *K*. In the cool *K* and *M* classes, molecular compounds are able to exist, as shown by broad bands which appear first in class *G*, and soon dominate in *M*, *R*, *N*, and *S*.

As the color of the light emitted from a star also depends on its temperature, we can correlate color and spectral classification. The hot, bright blue stars of class *B*, such as Rigel in Orion, are followed by the white stars of class *A*0, of which Sirius is best known. Canopus and Procyon are yellowish *F* stars, while the sun and yellow Capella are typical *G* stars. Orange Arcturus follows in class *K*, and lastly, red Antares and Betelgeuse represent the *M* stars. Class *O* stars are the hottest; *R*, *N*, and *S*, among the coolest, but these four groups comprise less than one per cent of all the stars.

NOTICE

Some copies of the June issue were printed in such a way that the pages do not run consecutively. If your copy is imperfect, a postcard will bring you a replacement immediately.

AMERICAN ASTRONOMERS

The Editors review some papers presented at the 70th meeting of the American As
Complete abstracts will appear, as usual, in the Publications of the Society an
For a general story of the meeting, see page 3.

Four Faint Globulars in Ophiuchus

A FEW years ago Dr. Helen S. Hogg, of David Dunlap Observatory, used the 36-inch reflector at Steward Observatory in Arizona to observe about a dozen globular clusters. In earlier lists of globulars published by Dr. Harlow Shapley, of Harvard, these particular clusters were notable for the lack of detailed information about them. The latitude of Steward Observatory favors observation of the Ophiuchus region of the sky.

Dr. Hogg reported to the society the results of her studies of four of these clusters, all of them comparatively faint objects. One, N.G.C. 6273, is the most elliptical globular in the sky, with a major axis nearly twice the length of its minor axis. Such a cluster must obviously be an oblate spheroid, instead of spherical, and shows that globular clusters are not necessarily spherical objects, as most photographs of the brighter ones might lead us to believe.

Distances of these clusters were derived about 14 years ago on the basis of their apparent integrated magnitudes and their apparent sizes. Dr. Hogg set out to make new distance determinations, at first using variable stars of known absolute brightness. She found only three or four such stars in each cluster, and as yet the observations at hand are insufficient to give their periods and absolute magnitudes.

Next she turned to the brightest stars in each cluster—these usually have a certain average real brightness. From their apparent brightnesses, she was able to deduce a distance for each cluster, but without taking into consideration the effect of dimming of the cluster's light by its shining through possible intervening clouds of interstellar dust and gas. Her new distances agreed remarkably well with the older work, in spite of its relatively low reliability.

These four clusters are situated near the central plane of the Milky Way, which means that obscuration of their light may be quite a factor in their apparent brightnesses. One, N.G.C. 6287, is very near a region noted for its high obscuration—as much as three magnitudes. In commenting on the paper, Dr. Shapley said, if N.G.C. 6287 is itself really obscured by this amount, then it may well be one of the nearest of all globular clusters. There is also the case of M4 in Scorpius, a globular which Dr. Jesse L. Greenstein, of Yerkes Observatory, has found to be probably nearer than Omega Centauri and 47 Tucanae, naked-eye clusters of southern skies, which have long been thought to be the nearest.

Dr. Shapley further mentioned that for globulars in higher galactic latitudes the problem of absorption was not so serious, or at least could be determined by the visibility of the more remote galaxies in the same directions, and that new determinations of the distances of some 30 globulars in these regions were practically ready for publication. He mentioned the four ways of getting a globular cluster's distance as being the same as applied to galaxies, in order of their increasing reliability: apparent diameter, total magnitude, brightest stars, Cepheid variables. For galaxies, he said that there is now a fifth way, the correlation between increasing distance and the shift of the spectrum toward the red, interpreted by many astronomers as indicating an expanding universe.

A Spectroscopic Triple

THE 5th-magnitude star 59d Serpentis appears as one object to the naked eye. In a small telescope it is a close double, with a separation of four seconds of arc. But spectra taken at the Michigan Observatory show that the brighter member of the double is itself a triple star, with three measurable spectra. This was discovered independently by McLaughlin at Michigan and by Tremblot at Paris in 1938; some of their discovery plates were even taken on the same night.

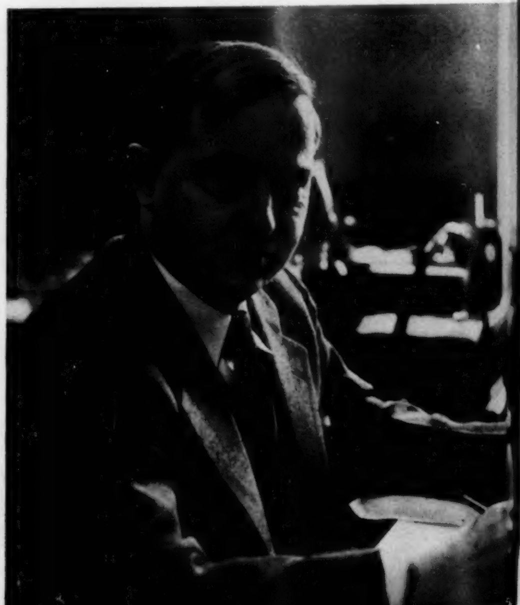
Mrs. Elizabeth Cornwall Tilley, of the University of Michigan Observatory, has completed an analysis of the velocity curves derived from the three spectra and obtained the orbital elements of the triple system, making this the first spectroscopic triple for which such information has been obtained. The triple star is composed of a giant yellow star (class *G*) and a pair of normal white (*A*-type) stars. These latter two are studied by means of the strong K lines of calcium in the violet region of the spectrum, where the *A* stars give more light than the *G* star. The *G* star dominates the longer wave-length part of the combined spectrum.

The *A* stars form a close binary of 1.85-day period, and they are separated by a distance of only 7,000,000 kilometers. Together with the *G* star, they revolve about the center of mass of the triple system in a period of 386 days, and are separated from the *G* star by the distance across the earth's orbit. This 386-day period makes it difficult to observe separately the spectra of the *A* pair, because right now it is in phase with the annual passage of the sun through the region of the sky near Serpens. By 1947, however, the phase difference will make it possible to obtain a more complete velocity curve than is had at present.

The distant companion to the triplet (the other component of the visual double) is also a white star of class *A*. It has shown only slight motion in the past century, so that its period must be of the order of a couple of thousand years. Its distance from the triplet is about 500 astronomical units, or some 46 billion miles.

400 Long-Period Variables

LEON CAMPBELL, recorder of the American Association of Variable Star Observers, has derived mean light curves for approximately 400 variable stars and classified them into several groups, dependent mainly on the forms of the light curves. The diversity of form is large. Some of the stars have broad, flat maxima and sharp,



Dr. Harlow Shapley, director of Harvard College Observatory and new president of the American Astronomical Society, was host at the May meeting. Photo by Robert Cox.

S REPORT

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narrow minima; others resemble sine curves. A large portion remain for months at minimum brightness and suddenly increase to maximum, frequently brightening more than 100-fold. Then they remain at maximum only a relatively short time and return slowly to minimum.

There are exceptional cases, such as R Centauri and R Normae, which present double maxima and minima, the former nearly of equal height, while the minima are of very unequal depth.

Eighty per cent of the long-period variables discussed belong to spectral class *Me*, in which there are strong emission lines of hydrogen. Numerous correlations between spectral type, range of variation, length of period, and form of curve have been studied, some very significant, others apparently not so much so.

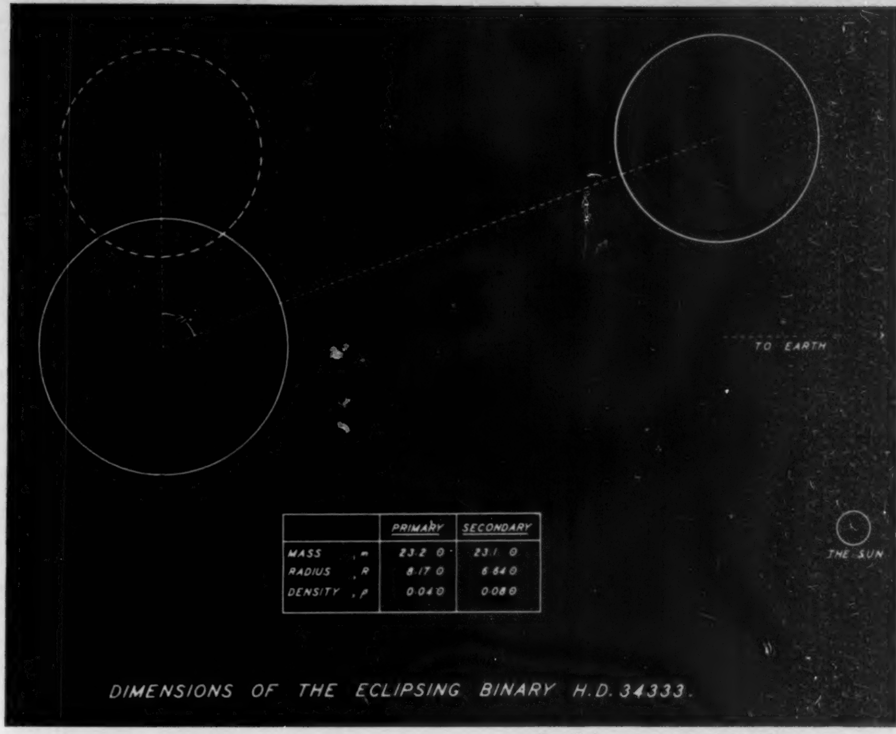
Intensity curves, which may represent more definitely than light curves what is taking place in these stars, have also been plotted.

Mr. Campbell stressed the part played by amateur astronomers all over the world in gathering the more than half a million observations he has used in this study. At the present time, reports from many foreign countries have been curtailed, but very few stars can be said to have been completely neglected by A.A.V.S.O. observers.

Magnitudes of Southern K-Type Stars

ONE of the projects under way at Harvard College Observatory is the determination from their spectra of the true luminosities of all the brighter stars (to at least 6.5 apparent visual magnitude) south of declination —20 degrees. This work is patterned largely after similar Mt. Wilson investigations on the northern stars. The paper presented by Dr. Dorrit Hoffleit reported provisional results for 329 stars, mostly between magnitudes 5 and 6, and of spectral classes *G*8 to *K*2.

These are stars with temperatures of the order of 4,000 degrees absolute for giants and 5,000 degrees for dwarfs. Only 13 of the stars are dwarfs, however, and they are not discussed in detail. The giant stars have absolute magnitudes ranging from —2.4 to +2.3, with an average of +0.4. This means that the majority of the stars are about 60 times brighter than our sun, with individual values ranging all the way from 700 down to nine times as bright.



Dominion Astrophysical Observatory

A Massive Binary

THE fifth most massive star known has been studied by Dr. J. A. Pearce, director of Dominion Astrophysical Observatory. It is the spectroscopic binary HD 34333 in the constellation Auriga, a star of the 8th magnitude, about 3,500 light-years away. Its binary character was discovered in October, 1941, but studies of its period were begun a year later. Dr. Pearce's paper gives the mass of each component as about 23 times that of the sun, while their respective radii are 8.2 and 6.6 times the sun's, as shown in the accompanying diagram. One star is about 1,500 times as bright as the sun, and the other about 900 times.

The separation of the centers of these two stars is about 38.5 times the sun's radius, or nearly the distance of Mercury from the sun. Their large masses produce powerful gravitation between them, with the result that their period of revolution is only slightly over four days (Mercury's period is 88 days). Their orbital velocities are, therefore, about 225 kilometers per second, so that when one star is approaching us and the other receding, the difference in the positions of their spectral lines corresponds to about 450 kilometers per second—a very noticeable shift. However, the spectral lines of both stars, which are blue-white and of spectral class *B*3, are diffuse and somewhat difficult to measure. The velocities obtained rest upon the measures of six pairs of hydrogen and helium lines on 30 single-prism spectrograms of dispersion 51 angstroms per millimeter at H delta.

Perhaps the most interesting feature of this system is the inclination of the orbit of the two stars, 71 degrees to the plane of the sky. Because of their relatively large sizes, this means that when the smaller star passes in front of the larger star a slight partial eclipse takes place, as seen from the earth. The size of this eclipse is shown in the diagram by that portion of the dotted circle which intersects the larger solid one. At most this represents a cutting off of the light of the two stars together of only 0.05 magnitude, an amount too small to detect except by observations with a light-sensitive photometer. However, the time in each 4-day period when this light fluctuation should take place can be accurately predicted, so Dr. Pearce suggests that such photometric observations be made. They would give useful information and would check the spectroscopic computations. We shall probably hear more of this interesting double star.

Search for Invisible Companions

EVIDENCE that new techniques revive old problems is found in the current program at the Sproul Observatory known as the *astrometric study of nearby stars*. Just about a century ago, Bessel predicted the existence of the companion of Sirius from observations of the bright star's variable motion across the face of the sky. In those days the observations were made visually, but they were precise enough to show that in a 50-year period Sirius was being swung back and forth by the gravitational attraction of an invisible companion. Later, the companion star was actually seen through a telescope.

By various means we have found that within about 16 light-years of the sun

there are 38 systems known, including the solar system. Of the others, three are triple, and eight double. It is to be expected, then, that if a careful search is made among nearby stars, say those within 32 light-years (10 parsecs) of the sun, and if the measurements are precise enough, further cases similar to that of Sirius can be discovered.

The astrometric observations with the refractor at Sproul Observatory, Swarthmore College, were outlined in a paper by Dr. Peter van de Kamp. In the fall of 1937, a systematic program was begun by reobserving the proper motions (movement across the face of the sky) of all stars within 32 light-years of the sun now considered to be single, and within reach of the 24-inch refractor. An attempt is made to obtain a minimum of four plates per year, each containing from one to about four exposures. Positions relative to a background of faint reference stars have a probable error of about 0".03 for a good plate with two exposures. For the very nearest stars, a larger number of plates is taken each year, since for them the apparent sizes of any variations in straight-line proper motion should be most noticeable.

Normally, a star which is really single, or which has only companions of small planetary mass, will proceed along its path through space in a straight line, and have a uniform proper motion. But if it has a companion of sufficient mass to produce what at one time would have been considered variations due to uncertainties of observation or measurement, the Sproul program should eventually show these up. Once variable proper motion has been established, more frequent observations can be made in an attempt to determine the elements of the orbit and the mass of the companion star.

Already accomplished in this direction is the discovery of the variable proper motion of the star Ross 614, as well as of the star +20° 2465. These discoveries were made by Dr. Dirk Reuyl at the McCormick Observatory. In each case, the variation is caused by an invisible companion.

A by-product of the program is the determination of accurate trigonometric parallaxes, thereby improving our knowledge of the distances of these nearby stars. In a separate paper, by Dr. van de Kamp and Dr. Hans Fried, the parallax determinations for six nearby stars were reported. These stars, incidentally, did not show any definite deviation from straight-line motion in the 5-year observing period. Further observations will continue.

Comet Whipple Spectra

THE diffuse nature of the nucleus of a comet has generally necessitated the use of a wide spectrograph slit to obtain satisfactorily dense plates of cometary spectra. Spectrograms of comets prior to 1937 had a "purity" such that the width on the plate of a monochromatic image of the spectrograph slit was two angstroms or more. Dr. Andrew McKellar reported that at Dominion Astrophysical Observatory this February and March a number of spectrograms of Comet Whipple 2 were obtained which covered the blue and violet regions with the highest spectral purity yet obtained for comets: a projected slit width of 0.55 angstroms at wave length 3880.

The Canadian astronomer closed his discussion of some of the main features of the comet's spectrum by announcing the tentative identification of the molecule NH_2 in Comet Whipple 2. This was a discovery made independently by Dr. McKellar, Dr. R. Minkowski, of Mt. Wilson Observatory, and Dr. P. Swings, of Yerkes Observatory. NH_2 is a physically stable, but chemically unstable (in the ordinary sense) molecule resulting from the dissociation of ammonia (NH_3).

An oxy-ammonia flame was set up at Victoria and its spectrum photographed. The correspondence of several of its strongest features with those of Comet Whipple 2 in the visual region led to the suggestion that the cometary emissions were probably due to NH_2. Also, the prior knowledge of NH bands in cometary spectra and the likelihood that they arise from the photo-dissociation of ammonia makes the presence of NH_2 in comets' heads very plausible.

Dr. McKellar is collaborating with Drs. Minkowski and Swings in publishing a detailed account of this tentative discovery and of studies of the visual region of cometary spectra in general.

Planetary Nebulae Spectra[1]

MOST studies of the planetary nebulae have dealt with the brighter, more easily observed objects. The reason for this is that reliable photometric studies and searches for faint spectral lines must be confined to nebulae where such features are bright enough to be seen. Nevertheless, studies of objects of low surface brightness should throw light on the structure and perhaps the evolution of the gaseous nebulae.

Dr. L. H. Aller, of Harvard College Observatory, reported on the study of plates taken at the Lick Observatory, loaned by Dr. N. U. Mayall, and concerning six nebulae of low surface brightness as well as six small planetaries of high surface brightness. Previously, Dr. R. Minkowski, of Mt. Wilson Observatory, had announced the results of a study of 26 planetaries of low surface brightness.

These faint planetaries generally show similar spectra for those of similar structure. Some are intermediate, both in spectra and appearance, between diffuse nebulae like the one in Orion and the typical planetaries.

Some of the small, bright planetaries, particularly one discovered by Dr. Paul W. Merrill, at Mt. Wilson, show strong forbidden lines of sulphur. Dr. Aller is inclined to the belief that these sulphur lines are strong because of physical conditions rather than because of a great abundance of sulphur in these objects.

[1]See "Ages of Observation," by L. H. Aller, *Sky and Telescope*, August, 1942.

Novae Spectra Studies

OSCILLATING absorption lines in the spectra of novae were discussed in a paper by Dr. Dean B. McLaughlin, of the Observatory of the University of Michigan. He stated that in novae spectra certain of the absorption lines seem to shift their positions to and fro as if variations in the speed of the gas doing the absorbing were taking place. However, he said that such oscillations were both real and apparent. Real oscillations are continuous changes of the displacement of a single set of lines, whereas apparent oscillations arise from variable blending of two or more components whose real changes of position are much smaller than the apparent shifts due to their changes of relative strength.

The real oscillations are closely connected in some cases with secondary changes in the total light of the star—fluctuations evident on every nova light curve. The greatest displacements seem to coincide nearly with the minima of such secondary fluctuations.

Among the novae studied by Dr. McLaughlin for this problem are Nova Geminorum 1912, Nova Pictoris 1925, Nova Herculis 1934, and Nova Aquilae 1936.

Orbit of VV Cephei

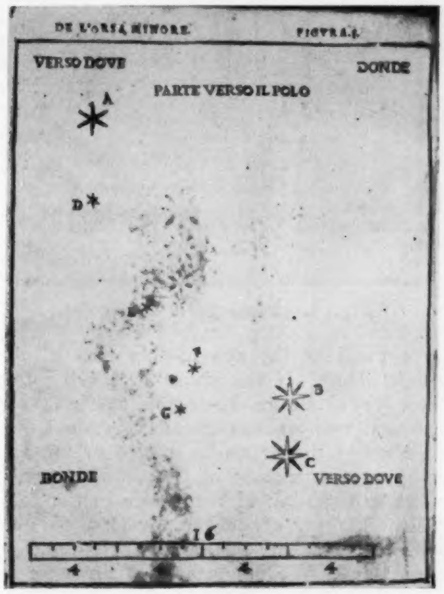
VV CEPHEI is an eclipsing variable star with a period of 20.4 years, consisting of a supergiant red (*M*-type) star and a smaller blue component of the *B* type. From the variations of its light curve while the blue star is undergoing eclipse by the red one, and from the Doppler shift of the lines in its spectrum, the orbit of this binary has been fairly well established, as well as the actual dimensions of the two stars. The blue one is about 22 times the diameter of the sun and 40 times its mass, while the red star is 3,000 sun diameters and 57 solar masses, making it practically the largest star known. However, its average density is extremely small, and its central condensation very high, as in the case of the star Zeta Aurigae.

The tremendous sizes involved in this double-star system have led astronomers to speculate on the possibility of actually observing its orbital motion by visual

ASTRONOMICAL ANECDOTES

AN EARLY STAR ATLAS

I HAVE before me an interesting old book. Indeed, it is really two books bound in one volume, the title page for the combination bearing the date MDXLVIII, and the place, Venice. The permission of Pope Paul III is acknowledged at the bottom of the title page. Those who have read all that has been published in recent months about Copernicus will recall that his book of 1543 was dedicated to Pope Paul III, but the work of Copernicus was ending while that of the author of the present book was beginning.



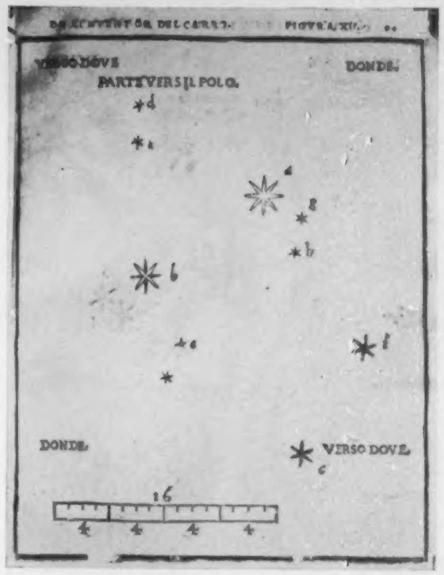
In Ursa Minor, Polaris is shown fainter than the equal Guardians of the Pole. This follows Ptolemy exactly, as does the order of the lettering follow Ptolemy's listing. Bayer used the same order.

Alessandro Piccolomini (1508–1578) was Archbishop of Sienna, and, according to *Who's Who in the Moon* (*Memoirs* of the British Astronomical Association, Vol. 34, Part 1), he was a "member of an ancient illustrious family." Elsewhere I have seen him called the Archbishop of Patrasso, but I've not yet settled the point. It is too bad that he is known to most astronomers as someone whose name was used for a lunar feature.

The first half of his book bears the title *De la sfera del mundo,* and is a conventional treatment of the established pre-Copernican astronomy. Some of the section headings will suffice to describe its contents: "Proof that there are ten celestial spheres," "The heavens revolve circularly," "The heavens are spherical," "The spheres of the planets move from west to east," "The Earth is spherical," "The Earth is in the center of the universe," "With respect to the starry heavens, the Earth is but a point," "The Earth is fixed and immovable," "The Earth does not have a motion of revolution." Ptolemy did almost the same thing, 1,400 years earlier.

The second half of the book bears the title *De le stelle fisse,* and is the important part of the work, for my present purpose. It is an atlas and description of the heavens. Each constellation is described in some detail, and the conspicuous stars are listed with descriptions of their positions in the constellations. The magnitudes are given.

Following the descriptions there are full-page woodcut illustrations, one for each of the 48 constellations. This is the important point, for it is commonly supposed that Bayer, about half a century after the date of this book, was the first to make maps of the individual constellations. Bayer is often given credit, too, for introducing star maps showing the groups as they appear to the eye, and not inverted as on a globe. But in this book they are true maps, to be matched with the sky, so Bayer was anticipated on this count, as well. And Bayer is usually given great credit for having devised the scheme of designating the individual stars in each constellation with separate symbols (Greek letters). Here, in this book published 55 years before Bayer's work, we find the stars indicated by Roman letters! Who is to say which is better? Certainly the printer's life would be easier if the scheme of Piccolomini had been adopted, instead of that of Bayer.



Auriga, called by Piccolomini "the inventor of the chariot," is drawn without Zeta Aurigae, one of the three Kids.

I wonder if Bayer saw a copy of this work? He must have, for the edition must have been very large; good copies can be purchased today for less than \$20. And there are certain coincidences between the order of the assignment of letters which are not likely to have been completely accidental, when the authors deviate from the order in which the stars are listed by Ptolemy. In the work of Piccolomini, the order of the constellations is precisely that of Ptolemy, while Bayer interchanged Hydra and Centaurus. The magnitudes (four are marked on the maps) and the star positions of the Italian writer are those of Ptolemy.

Those who have worried about Castor and Pollux in Bayer's work might here well worry about the omission of Zeta Aurigae, although the other two "Kids" are shown; was the star at minimum?

R. K. M.

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or photographic means, in addition to our knowing its elements from the photographic light curve and the spectral line shifts. Consequently, at Sproul Observatory, Swarthmore College, where precision photographic methods of recording star positions have been developed, some 291 photographs of VV Cephei have been taken in the past five years, including 909 exposures. This program has been carried on by Dr. Gustav Land, now at Yale Observatory, in collaboration with Dr. Peter van de Kamp, director of Sproul Observatory.

The period of these observations includes just the time when the red giant in VV Cephei is reaching the "end" of its orbit as it is projected to our view. In other words, during this period it changes its apparent orbital motion from one direction across the sky to nearly the opposite direction. The same motion, in the opposite sense, occurs with the blue star, but in the region of the spectrum in which the Sproul observations are made, most of the light should be coming from the red component and any change in position of the system should be mostly attributable to the giant star.

The actual positional changes are very small, and additional results from observations during the next 15 years will be needed to observe the complete orbit, although before that time its apparent size may have been determined. A preliminary study of the observed positions indicates that the big star has accomplished its about-face, but that the *apparent* size of its orbit is at least three times larger than has hitherto been considered probably correct. This discrepancy may call for a revision in the estimates of the star's distance from us, which is now put at about 3,000 light-years, reducing it to about one third.

So large is the red star in the system that each eclipse lasts two years. The next one, starting in 1956, will reveal more facts about VV Cephei.

GLEANINGS FOR A. T. M.s

That Roof Prism Problem

IN 1941, about the time of Pearl Harbor, government procurement officials were extremely bothered by the lack of those many-sided geometrical shapes of optical glass known under the collective name of roof prisms. The Services were demanding armament—tanks and trucks and planes and ships and guns—especially guns. Now, mounted on the side of every gun is a little something to aim it with—what the Army calls a panoramic sight—and inside this panoramic sight is a roof prism, as shown in Figure 1. Moreover, on the other side of the gun is another telescope—for direct fire—and in this telescope is another roof prism. So that making guns and more guns was a little more than a process of taking more metal from more blast furnaces and putting it into more lathes—there was the matter of instruments to go on these guns. And optical instruments cannot usually be produced by the thousands and tens of thousands by the simple process of buying more machinery and hiring more men.

It would have been enough to have had to make a few hundred thousand extra lenses with comparatively few facilities or skilled workmen and little optical glass. But roof prisms! There were not more than one or two dozen men in the country who could turn out good roof prisms. And even the best man cannot do more than 50 a week—the average is nearer 10, for excellent workmen.

Redesigning instruments to replace roof prisms with other types of optical elements, more easily made, would have required months, perhaps years. And besides, military instruments have to have roof prisms, for substitute elements make the instruments too long, or too large, or introduce other difficulties.

The roof prism is the optician's nightmare. Its guiding principle is the "roof," which is merely a 90-degree gable, substituted for what would ordinarily be a single plane face. If we take the ordinary right-angle prism shown in Figure 2a, and add a roof to its hypotenuse, it will be as shown in Figure 2b. Its purpose is to invert an image in two planes —to erect it.[1] Two mirrors inclined at 90 degrees have the same effect, and are often used in demonstrations to give an observer an image of himself which is the same as he is seen by others, not inverted as in an ordinary mirror.

As can be seen from Figure 2b, a prism with so many polished faces (four), with planes existing in all three dimensions, would be difficult enough to make, but there is an additional difficulty—the faces of the roof must be perpendicular to each other within a tolerance of two seconds of arc—the apparent size of a dime ½ mile away. If this tolerance is exceeded, the prism will give a double image. A common test of a right-angle prism is to look into it from the hypotenuse face and examine the image of

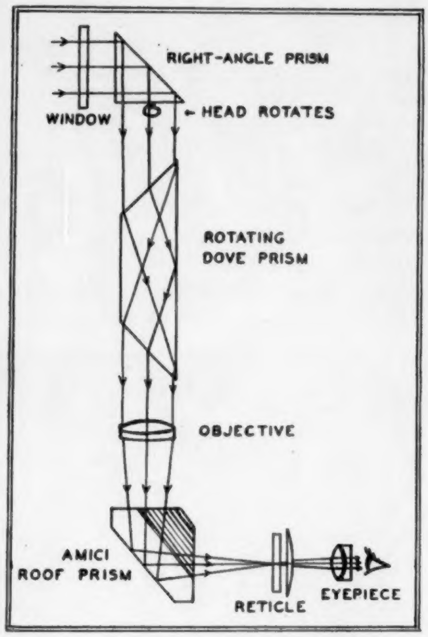


Fig. 1. Panoramic telescope.

the pupil of the eye in the apex of the right angle. If the image of the pupil is not circular, the 90-degree angle is off. When we perform this experiment, we are using the prism as a roof prism, and any non-circularity of the pupil image is due to doubling of the image in the roof. The images, of course, overlap to give an elliptical or dumbbell appearance to the pupil. We cannot detect an error as small as two seconds by this visual method, but it shows up under the magnification of an instrument.

There are several types of roof prisms, shown in Figure 3. The most important and most common is the Amici (a). This is nothing more nor less than the right-angle roof shown in Figure 2b, with the sharp corners chopped off to avoid breakage. Every Army gun needs two of these. We're not giving away any military secrets here—every nation in the world

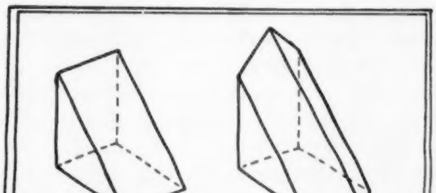


Fig. 2. Ordinary and roof prisms.

uses these instruments and these prisms. Abbé, who was the founder (from the designing point of view) of the optical firm of Carl Zeiss in Germany, invented the roof prism. The Abbé prism (3b) was the first type. The Brashear-Hastings (3c) is an American modification of the Abbé type. Figure 3d shows the Leman prism, used by Zeiss in a special type of binocular which gives a greater distance between the objectives—hence greater stereoscopic power. It is also used in

[1] Incidentally, an Amici in place of the right-angle prism in a reflecting telescope will adapt it for terrestrial observation.

military instruments. The trough cut out of the back is for mounting purposes.

The story we want to tell, however, is of the connection of A.T.M.s with this picture. We have every reason to be proud of our fraternity for the work it has done to help solve the problem of roof prisms.

Making a roof prism correct to two seconds of arc is a task of hand-correcting a flat surface. Not many professional lens-polishers know anything about hand-correcting of optical surfaces, but nearly all amateur telescope makers know a great deal about it. This doesn't mean that they can all make good roof prisms—these require a special technique of their own—but amateurs do have a great deal of background for a task like this. And at a time when the war effort needed roof prisms as badly as it needed any single item of war materiel, the A.T.M.s came forward and put their skill to work to clear this bottleneck. Some put aside

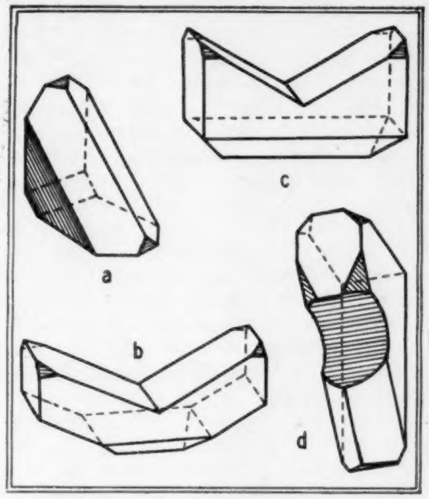


Fig. 3. Types of roof prisms.

their businesses and set up little optical shops; some worked in their spare time. A few, perhaps, went into it for the financial reward, but not many. There were about 80 of these amateurs, and the large majority of them came through with flying colors to prove the capabilities of amateurs to people who were more than a little skeptical at the outset.

These A.T.M.s are making roof prisms now—and the bottleneck is past. Enough time has passed now for men and women in arsenals and in private optical concerns to have been trained in the tedious, painstaking task of hand-correcting roofs, and some more or less mass-production techniques have been evolved. But the telescope makers are not out of the picture. They still have and are getting contracts for roof prisms.

Albert G. Ingalls, of **Scientific American** (Telescoptics) and **Amateur Telescope Making**, deserves a great deal of the credit, together with Russell W. Porter, who has done more for the cause of amateur telescope making than anyone else. It was these men who contacted the government officials, sold them on amateur potentialities, obtained trial contracts and glass blanks for practice, rounded up amateurs whose work indicated they might be able to make good roof prisms, dug up all the possible material on how the job could best be done, and kept the little group, all over the country, tied together and working together for each other's good.

"Unc" Ingalls has told the complete story in **Scientific American** for May. To Ingalls and Porter, the entire telescope-making fraternity owes a heart-felt vote of thanks for showing that the amateur telescope maker can compete on even ground with the professional on the most difficult optical task of all.

GLEANINGS is always open for comments, contributions, suggestions, and questions, from its readers. We are here to serve, in every possible way, those of the telescope-making fraternity who are among the readers of "Sky and Telescope."

Sauce for the Gander

READERS are asked to send in questions, from which this editor will select the best each month to answer here. The last question is left unanswered, but the reader should be able to find the answer for himself. This month's question is from Mrs. H. W. Shimer, of Hingham, Mass.

Q. Can you tell me anything about a "blue moon"? In the midst of somewhat more important matters a group of us have found time to puzzle about it.

A. There are at least two possible origins of this expression. The more elaborate is given in the **Maine Farmers' Almanac** for 1937. "The moon usually comes full twelve times in a year, three times in each season. These moons were named as follows: Moon after Yule, Wolf Moon, Lenten Moon, Egg Moon, Milk Moon, Flower Moon, Hay Moon, Grain Moon, Fruit Moon, Harvest Moon, Hunters' Moon, Moon before Yule. However, occasionally the moon comes full thirteen times in a year. This was considered a very unfortunate circumstance, especially by the monks who had charge of the calendar. It became necessary for them to make a calendar of thirteen months for that year, and it upset the regular arrangement of church festivals. For this reason thirteen came to be considered an unlucky number. Also this extra moon had a way of coming in each of the seasons so that it could not be given a name appropriate to the time of year like the other moons. It was usually called the Blue Moon. There are seven Blue Moons in a Lunar Cycle of nineteen years. In olden times the almanac makers had much difficulty calculating the occurrence of the Blue Moon and this uncertainty gave rise to the expression 'Once in a Blue Moon.'"

The principal objection to this theory, from a purely astronomical point of view, is that the blue moon is not such a rarity as to account for the common expression. Another and simpler explanation is that a blue moon is merely a moon that appears blue. This phenomenon would be purely local, and due to unusual refraction in the upper atmosphere. Some astronomers have doubted whether it ever occurs, but an instance was reported in The SKY, November, 1939, page 18.

Q. What is the location of the antapex? L. J. LAFLEUR

BOOKS AND THE SKY

SCIENCE FROM SHIPBOARD

Various authors. Science Service, Washington, D.C., 1943. 268 pages. 25 cents.

THIS is a convenient little book that you can carry in your pocket, and it is packed with delightful reading matter of especial interest to the soldier, sailor, or traveler on board ship.

Here you will find such things as the whys and wherefores of the trade winds and storms, the weather to be expected along the various trade routes, the significance of the weather elements, and instructions for making simple observations of real scientific value.

Astronomy, of course, is included. This section covers 80 pages and furnishes an excellent elementary treatise on the subject. A voyage on a blacked-out ship will naturally furnish a rare opportunity to become familiar with the constellations, to trace the wanderings of the planets, to observe the features of the moon and sun in so far as they can be seen with binoculars, to record meteors and anything else unusual, and also to learn the modern theories of the solar system, the Milky Way, and the exterior galaxies.

Navigation, including piloting, dead reckoning, and celestial navigation, is made as clear as is possible without the use of mathematics. There are also some hints as to emergency navigation—in a lifeboat, for example.

Life in the sea from whales to microscopic plankton is described and methods of collecting the smaller forms suggested.

Above the sea, attention is called to a great variety of birds, from the gliding albatross with its 12-foot wingspread to the tiny petrel that walks on the sea like Saint Peter of old.

Geology, too, may be studied and enjoyed on the voyage. Lofty mountainous islands, low-lying atolls, graceful sand beaches, rugged rock-bound coasts, all are described and their evolution traced.

Your ship is discussed, its structure, buoyancy, tonnage, motive power, and so on.

As for yourself, the author of this chapter naturally starts with your seasickness and its causes. He also discusses such things as infections, bacteria, vitamins, exposure, thirst, and even some forms of mental disorders.

As Dr. Harlow Shapley says in the Foreword, the book was written not merely for the diversion of travelers confronted with the tedium of a long voyage, but also to create respect for the meaning and methods of science.

Each chapter is written by a specialist. Here is the list of authors: Dr. Charles F. Brooks, Dr. Priscilla F. Bok, Dr. Bart J. Bok, R. Newton Mayall, Margaret L. Mayall, Charles A. Federer, Jr., Lt. James Cuffey, Dr. Kirtley F. Mather, Dr. George L. Clarke, Dr. Ludlow Griscom, Lt.-Comdr. J. P. Den Hartog, Dr. C. F. Taylor, and Dr. R. W. Gerard, nearly all members of the Boston-Cambridge Branch of the American Association of Scientific Workers.

FREDERICK SLOCUM
Van Vleck Observatory

STEREOPIX

Wm. H. Barton, Jr. Hayden Planetarium, New York, 1943. Unpaged. $1.50.

AT THE present time when so much celestial navigation is being taught, it is of the greatest importance that every possible aid be used in making clear to the student the various co-ordinate systems encountered in its study. Those schools which have access to a planetarium are most fortunate, but many do not, and hence any practical visual aid to instruction is most welcome.

To this extent **Stereopix** is a valuable help to instruction. By means of special drawings and printing, and with a viewer supplied with each copy, the diagrams in the book present a three-dimensional appearance. Captions accompany each presentation of one of the principles involved in celestial navigation. Any instructor of navigation knows the difficulty of trying to draw such three-dimensional pictures on a blackboard.

Concerning adverse criticisms, one might object to the circular border for Figures 8 and 9; it appears a bit confusing and unnecessary. Figure 3, showing the motion of the northern sky, seems a little unnecessary.

Nevertheless, these slight criticisms detract but little from the useful purpose that the diagrams can serve, and it is felt that the book is definitely worthwhile.

E. G. EBBIGHAUSEN
Allegheny Observatory

NEW BOOKS RECEIVED

SEXTANT AND SAILS, The Story of Nathaniel Bowditch, *Robert Elton Berry*, 1943, *Dodd, Mead.* 231 pages. $2.50.

The author of the recent biography of Bowditch writes for older boys and girls an interesting and attractively illustrated life of the great navigator.

STEREOPIX FOR CELESTIAL NAVIGATION, *Wm. H. Barton, Jr.*, 1943, Hayden Planetarium, N. Y. Unpaged. $1.50.

A novel presentation of the principles of celestial navigation provides three-dimensional diagrams and a "viewer," with descriptions of each illustration.

Amateur Astronomers

COPERNICAN CELEBRATIONS

INTEREST in the Copernican quadricentennial and co-operative participation in its celebration were widespread among amateur societies throughout the country. Programs and reports of commemorative meetings have been received from a number of groups.

Seven hundred persons attended the celebration in Detroit, which was held on May 22nd at the Rackham Memorial building. Mrs. Margaret Back, secretary of the Detroit Astronomical Society, which, with the Friends of Polish Arts, sponsored the meeting, writes:

"We were granted the one fine day in weeks of gloomy rain. Our tableau was really very fine . . . taken from a painting by Brausewetter, depicting Copernicus standing in long robe and cap on the observation tower, holding in one hand a lovely old lantern and in the other a script, as he bent over a large globe. The lighting was superb —very dim, blue indirect lighting glowed from above, and the highlight, from one candle in the lantern, shone on his face. Our master of ceremonies, Mitchell Jachimski, a Polish radio commentator, was all that was needed to make the program slip along without a hitch. After the meeting, crowds lined up till midnight at the telescopes on the terraces. The consensus of opinion seemed to be that never had anyone attended such an entertaining meeting, and yet one so truly in keeping with the scientific atmosphere of the commemoration type of astronomical affair."

A recent *Bulletin* of the Eastbay Astronomical Association at Oakland, Cal., announced that their meeting of April 3rd was devoted to celebration of the quadricentennial, with a lecture, and discussion of the many sides of Copernicus' life.

The Burnham Astronomical Society, in Chicago, devoted its regular monthly meeting on June 8th to the quadricentennial of Copernicus, and had as speaker Mrs. H. Majewski, of the Polish information center.

From Milwaukee, notice was received of a meeting on Sunday afternoon, May 23rd, at the lecture hall of the Milwaukee Public Museum. Fostered by 76 Polish-American civic, fraternal, and religious societies, and with its principal address delivered by Herbert W. Cornell, member of the Milwaukee Astronomical Society, the meeting had a varied program. Tribute to Copernicus and to Poland included music, songs and costumes.

Some 30 or 40 members of the New York amateur society attended the celebration at Carnegie Hall, Monday evening, May 24th. The impressive meeting there was sponsored by the Kosciuszko Foundation and held under the auspices of the Copernican quadricentennial national committee, Dr. Harlow Shapley, of Harvard College Observatory, chairman. A number of speakers, and appropriate Polish music of varied kinds, were heard. Copernican citations were awarded 10 prominent men, among them Drs. Albert Einstein and E. O. Lawrence. The program announced the citations as follows:

"Copernicus in his day was a revolutionary and achieved revolutionary results. In our own day and generation we have individuals who have also produced and are producing revolutionary results in thought, science and industry. . . . a Copernican Citation is bestowed upon a number of typical 'modern revolutionaries' selected by a special Committee on Citations."

NEW YORK AMATEURS ESTABLISH MEDAL

By recent action of the board of directors of the New York Amateur Astronomers Association, this society has established The Amateur Astronomers Medal, to be awarded from time to time to an amateur astronomer (or layman) who, in the judgment of the board of directors, has performed such outstanding service to the cause of astronomy as merits such an award. Rules for the submission of nominations and the method of determining worthy recipients, as well as the time and place of making these awards, are yet to be worked out.

We believe that this establishment of a medal by a purely amateur society, and open only to amateurs, without restriction as to the particular nature of their service to astronomy, is the first action of its kind in the country. We believe also that this award should do much toward stimulating interest in astronomy on the part of the general public. It seemed especially fitting to establish the medal in the year of the Copernican quadricentennial.

About 30 amateurs and their friends spent Saturday afternoon and evening of Memorial Day weekend inspecting the A.A.A. camera station at Oceanside, Long Island, where we observed and photographed the sun, had a demonstration of sundial construction, and passed the evening observing with telescopes and high-power Zeiss binoculars.

Although we have been lately confining our field trips to points of interest close to home, due to the familiar wartime shortages, we have found our excursions stimulating and worth while.

GEORGE V. PLACHY, secretary
Amateur Astronomers Association

PROBLEMS OF STELLAR EVOLUTION

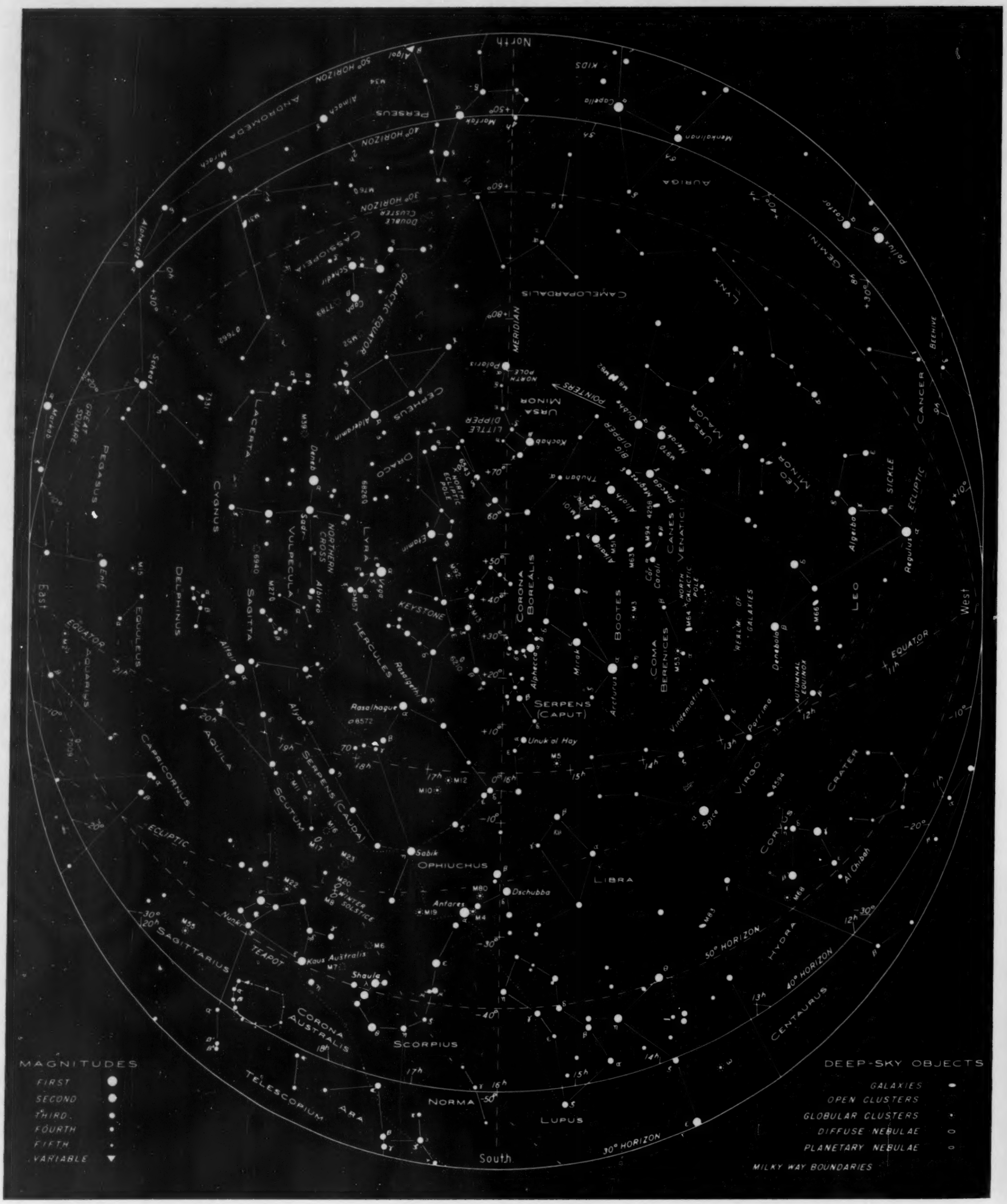
(*Continued from page 7*)

food of the stars is a milestone that will not soon be left behind.

Another unsolved problem is that of the company which the stars keep. Many pairs of stars are like identical twins, of the same size, brightness, temperature, and undoubtedly of the same age and history, and fed by the same food. But one need not look far before encountering an ill-assorted couple. It goes by the name of VV Cephei, and consists of a comparatively small blue star and an enormous red one, 3,000 times the diameter of the sun. They revolve around each other in 20.4 years. Not only do they *look* different, but their whole organization must *be* different. The small blue star must be feeding on the carbon cycle, while the red giant is still nourished on lithium or beryllium. How did this couple come together? How long have they been associated? Has the red star been coupled to the blue one since its birth?

If this were an isolated instance it need occasion no surprise—a few ill-assorted couples may always be expected. But VV Cephei is typical of a large group of stars, to which observations continually add new members. It is a case of what Merrill has happily called stellar symbiosis, and it presents one of the more fascinating unsolved problems of astronomy.

This question does not arise only with double stars. There are whole stellar clans, among those groups of stars called galactic clusters, that consist partly of middle-aged stars, partly of infants. Have we been wrong in supposing that these clans of stars, grouped together, moving together, were born together and have moved in unison since their birth? It is evident that although we may know something of stellar births and stellar nutrition, on the problem of stellar sociology we have scarcely made a beginning.



DEEP-SKY WONDERS

THIS month finds the following objects in good position for observation with moderate-sized telescopes. Descriptions are from Norton's **Star Atlas**.

Serpens. M5, 15^h 15.9^m, $+2°$ 16′. Globular cluster, 15′ in diameter, with a much-compressed center, and stars of about 11th to 15th magnitude.

Scorpius. M4, 16^h 20.5^m, $-26°$ 24′. M80, 16^h 14.1^m, $-22°$ 51′. Two globular clusters, the first about 13′ in diameter and easily resolved, the second rather condensed, both of rather faint stars.

M6, 17^h 36.7^m, $-32°$ 10′. A beautiful open cluster "like a butterfly with open wings." M7, 17^h 50.7^m, $-34°$ 48′. A brilliant open cluster of bright stars, and visible to the unaided eye.

Centaurus and Hercules. From our May and June lists we recall Omega Centauri and M13, the latter pictured on our back cover this month.

THE STARS FOR JULY

as seen from latitudes 30° to 50° north, at 10 p.m. and 9 p.m. on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

AIR AND SEA AND SKY

A department devoted to wartime subjects related to astronomy, such as aerial and celestial navigation, and meteorology.

NAVIGATING IN THE AIR — III

THE use of the line of position is not by any means restricted to the obtaining of fixes. For example, in daylight, when the sun may be the only body available, it is impossible to obtain a celestial fix at any particular time; nevertheless, successive single lines of position are extremely valuable.

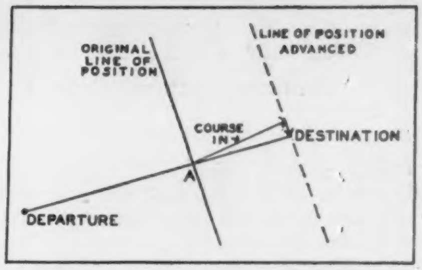
Prominent among the uses of the single line of position in aerial navigation is the case in which the observed body lies almost directly ahead of or behind the plane. The resulting line of position will then intersect the course of the craft at large angles, and the intersection will be the best known position of the craft, such as the point **A** on the diagram. The assumption that the plane is on course is legitimate if the navigator has been carefully checking his drift and compass throughout the flight, and excellent results are often obtained from this method.

A still greater advantage lies in the case in which the plane is **not** assumed to be on course and a landfall is made by using a single line of position. In order to understand this procedure, it is necessary to bear in mind that the line of position represents a series of positions, of which one is that of the craft. When one line only is available, as in the cases under discussion at present, it is impossible to determine exactly where the plane is; the only information is that the plane is somewhere on the line.

Now if the plane were to continue flight in the same direction and at the same rate of speed for, let us say, 25 miles beyond a certain line of position, its new position would still be unknown, but it would now lie on a new line each point on which is 25 miles from a corresponding point on the old one. In other words, the new line of position would be parallel to the original one, and 25 miles beyond it. This is the basis of the well-known navigation technique of **advancing the line** of position.

If, in addition, the second line of position were to pass through the plane's destination, the navigator would know that by running down the line one way or the other he would eventually reach his objective. This is called **landfall by single line of position,** and is used when the plane is near destination—near enough so that errors in subsequent dead reckoning will not affect the accuracy of the results.

In practice this works out almost as simply as has just been described. For purposes of calculating his ground speed, the navigator assumes the plane to be on course, unless he has good reason to believe otherwise. Then, having obtained an intersection of the course with the single line of position, he measures back along the course to his point of departure (or some other well-established position) and finds the distance run. Combining this with the time flown gives him his approximate ground speed (it would be exact if the plane were actually on course). Now he may estimate the wind, or, if he is not far from destination, he may neglect it.



Landfall by single line of position.

Next he measures the distance on course from the line of position to destination. Then he draws through his destination a line parallel to the original line of position. Knowing his ground speed, he knows when he will arrive at this line. But when he is on this line, the destination may be directly below him, or it may lie to the left or right—he has no means of knowing which. So he purposely puts the plane off course, far enough off so that he is sure to be on one particular side of his objective.

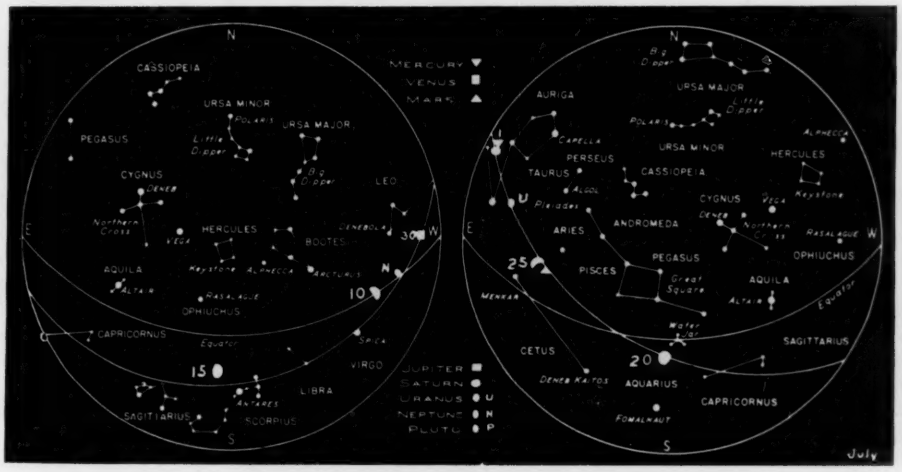
Unless the line of position is exactly perpendicular to his course, one way in will be shorter than the other, and he generally chooses that way. Thus, in our diagram, the shortest way to go in would be to the left of the course, and the navigator would, other things being equal, put himself off course to the left, and come in to destination from the northwest. The exact course in, naturally, will be the bearing of the line of position itself; in this case the course in would be about 160°.

The important thing, of course, is to be sure of the exact time at which the plane arrives on the line through destination, and to take up the proper heading at that instant. A knowledge of the wind is advantageous, unless the distance to be traveled is small, or the visibility is good, so that even if the plane misses by a few miles, the destination can be picked up.

Results obtained by this method are strikingly good, and the procedure is often used in flying to obscure destinations, such as the small islands in the Pacific, many of which are literally specks on the great expanse of water.

In general practice, it is usual to make more than one observation for the line of position, in order to check the work. Some navigators then use the average bearing of all the lines to come in to destination, although it can be shown that this procedure is not strictly accurate. S. S.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 4:30 a.m. on the 7th of the month, and at 3:30 a.m. on the 23rd. At the left is the sky for 10:30 p.m. on the 7th and for 9:30 p.m. on the 23rd. The moon's position is marked for each five days by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury, Jupiter, Saturn, and **Uranus** are too close to the sun for observation.

Venus reaches greatest brilliance this month. See special article on page 22.

Earth will reach aphelion at 6:00 a.m., July 4th, 94,556,000 miles from the sun.

Mars, in Pisces and Aries, will reach magnitude 0.3, about as bright as Rigel, at the end of the month.

Neptune is in Virgo.

OBSERVER'S PAGE

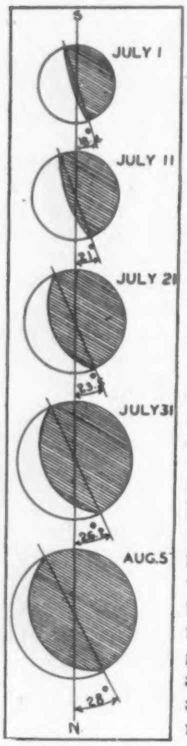
By Jesse A. Fitzpatrick

All times mentioned on the Observer's Page are Eastern war time.

Venus at Greatest Brilliance

THE planet Venus will occupy the center of the celestial stage through the entire month of July. Traveling eastward through the constellation of Leo, except for a brief passage across the northeast corner of Sextans, it will cross from the north to the south side of the ecliptic on July 13th. This point of crossing, the descending node, is slightly more than one degree west of Rho Leonis, magnitude 3.85, which lies very close to the ecliptic.

From June 27th, when the planet will have been at greatest eastern elongation, 45° 26′ from the sun, until its greatest western elongation, 46° 40′, on November 16th, Venus will interest both layman and astronomer. During this period, which is repeated approximately every 19 months, the planet's stellar magnitude is —4.0 or slightly brighter, except for the middle four or five weeks, when it is passing near the sun in its transition from an evening to a morning star.



Phases and changing apparent size of Venus this month.

During the first and last six weeks of this period, Venus can easily be seen in the daytime with the unaided eye, but of course one must know just where to look for it. It will be in fairly close conjunction with the crescent moon, four days from new moon, on July 6th, August 4th, October 25th, and November 23rd, and at these times, with the moon as a guide, the planet may be found.

It is also during this interval of nearly five months that Venus is brilliant enough to cast shadows and throw a "wake" on the water similar to that of the moon. The long twilight in July and early August will dim this phenomenon, and I recommend an early-morning observation on the 23rd or 24th of October when the moon and planet are in the same part of the sky and casting "wakes" simultaneously. The sky in that month will be much darker than in July.

On July 6th, Venus will be occulted by the moon, but since the occultation is of the negative type, with the geocentric conjunction east of Greenwich, it will occur very near the eastern horizon at our local station. The immersion, only 50 minutes after moonrise, at about 10 o'clock in the morning, will be difficult to see unless atmospheric conditions are perfect. People living farther east, at Boston or on the coast of Maine, will find conditions more favorable, since the moon will be higher in the sky. It is unfortunate that daytime will interfere with the observation of this phenomenon, which is one of the most spectacular events that we can see. In this particular case, the position angle of the immersion is at 113°, and as the position angle of the moon's axis will be 21°, the planet will disappear only 2° south of the moon's equator, or almost halfway between the tips of the horns of the four-day-old crescent moon. Just prior to the immersion we should see the perfect "star and crescent."

Prism binoculars are more effective in viewing an occultation of this type than the amateur's ordinary refractor or reflector—6x30 or 8x40, both of which grasp 25 per cent of the relative light from an object, are preferable to the popular 8x30, where the light grasp is only 14 per cent. A reflector of the richest field type, with a 4-inch mirror and power about 20x, should give good results.

Also on July 6th, but later in the day, Venus will be very close to Regulus. The actual conjunction in right ascension will occur at 3:00 p.m., when Venus will be 16′ north of the star. Because of the planet's sharp southeasterly motion, this separation will decrease to 11′ by dark.

The period of greatest brilliancy will occur at the end of the month when Venus' magnitude will remain at —4.2 for about 10 days before and after July 31st, the computed date for the maximum brightness. Through the month, the phases of Venus will undergo the same changes as those of the moon beginning with the day after last quarter and ending with the crescent phase five days before new moon, as shown in the diagram. On August 5th, the phase of the planet will be very nearly the same as that of the four-day-old crescent moon on that date; both objects will be in the same part of the sky, although not close together. A diagonal eyepiece used with about 75x will show a remarkable resemblance between the telescopic appearance of Venus and a naked-eye view of the moon. A rectifying eyepiece will accomplish the same result.

Next month we shall study a diagram of the orbital positions of Venus and the earth from June to November.

SIMULTANEOUS OCCULTATIONS

THE occultations of the twin stars, 15 and 16 in Sagittarius, of magnitudes 5.4 and 6.0, during the evening of July 15th, has many features of interest for the amateur. These stars have practically the same position in right ascension, there being only the slight difference of 0.5 of a second. The separation in declination is 20′.4, or two thirds the apparent diameter of the moon, making it possible for the two stars to be occulted at the same time. They are extremely hot blue-white stars, spectral class **B0** and **B1**, and are located in the great Sagittarius star cloud, five degrees northwest of Lambda Sagittarii, the star at the top of the Archer's bow. Interesting neighbors are the clusters and nebulae, M8, M20, M22, and M24. The fainter star, 16, is to the north, and they are both very close to Mu Sagittarii.

At New York City the immersion of 15 will occur 18.5 minutes earlier than that of 16, whereas at Washington, D. C., where the paths of the two stars behind the moon will be farther to the south, the interval between immersions is reduced to 7.6 minutes.

Going still farther south to Danville, Va., just north of the North Carolina border, the interval becomes only 18 seconds and the order of disappearance is reversed, 16 being occulted before 15. This shows that at some location just a very few miles north of Danville, there will be a simultaneous occultation of the two stars. At Danville, the predictions for the immersions are: 16, 9:26.6 p.m., P.A. 53°; 15, 9:26.9 p.m., P.A. 129°.

As far north as Boston, the star 16 will pass barely over the top of the moon at about 9:30 p.m., when it will be just dark enough for the star to be seen.

PHASES OF THE MOON

New moon	July 2,	8:44 a.m.
First quarter	July 10,	12:29 p.m.
Full moon	July 17,	8:21 a.m.
Last quarter	July 24,	0:38 a.m.

PLANET AND STAR CHARTS

On the preceding pages are our monthly star chart of the evening sky, for use by observers in latitudes 25° to 55° north, and the planet charts for both morning and evening skies as seen from 40° north.

OCCULTATIONS—JULY, 1943

Local station, lat. 40° 48′.6, long. 4^h 55.8^m west.

Date	Mag.	Name	Immersion	P.*	Emersion	P.*
July 6	—4.0	Venus	10:01.7 a.m.	113°	11:08.8 a.m.	268°
6	+6.8	BD +11° 2217	9:50.1 p.m.	174°		
10	5.8	80 Virginis	11:52.1 p.m.	39°	0:36.6 a.m. (11)	1°
13	7.2	BD —17° 4534	1:31.6 a.m.	138°		
15	6.5	166 B Ophiuchi	2:33.0 a.m.	22°	2:55.0 a.m.	342°
15	5.4	15 Sagittarii	9:33.5 p.m.	112°	10:46.4 p.m.	262°
15	6.0	16 Sagittarii	9:52.0 p.m.	26°	10:17.0 p.m.	347°
16	5.0	21 Sagittarii	2:57.0 a.m.	58°	3:55.0 a.m.	294°
25	6.2	BD +10° 401	2:18.9 a.m.	60°	3:20.9 a.m.	256°

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

Here and There with Amateurs

This is not intended as a complete list of societies, but rather to serve as a guide for persons near these centers, and to provide information for transplanted amateurs who may wish to visit other groups.

City	*Organization*	*Date*	*P.M.*	*Season*	*Meeting Place*	*Communicate with*
BOSTON	Bond Ast. Club	1st Thu.	8:15	Oct.-June	Harvard Obs.	Homer D. Ricker, Harvard Observatory
"	A.T.M.s of Boston	2nd Thu.	8:15	Sept.-June	Harvard Obs.	C. S. Cook, 16 Belfry Terr., Lexington
BROOKLYN, N. Y.	Astr. Dept., B'klyn Inst.	Rd. Table 3rd Thu.	8:00	Oct.-April	Brooklyn Inst.	William Henry, 154 Nassau St., N. Y. C., *BA.* 7-9473
BUFFALO	A.T.M.s & Observers	1st, 3rd Fri.	8:00	Oct.-June	Mus. of Science	J. J. Davis, Museum of Science
CHATTANOOGA	Barnard A. S.	4th Fri.	7:30	All year	Chattanooga Obs.	C. T. Jones, 1220 James Bldg., *CHat.* 6-8341
CHICAGO	Burnham A. S.	2nd, 4th Tue.	8:00	Sept.-June	La Salle Hotel	Miss W. Sawtell, 928 N. Harvey Ave.
CINCINNATI	Cin. A.A.	2nd Fri.	8:00	Sept.-June	Cincinnati Obs.	Dan McCarthy, 1622 DeSales Lane
CLEVELAND	Cleveland A. S.	Fri.	8:00	Sept.-June	Warner & Swasey Obs.	Mrs. Royce Parkin, The Cleveland Club
DAYTONA BEACH	D. B. Stargazers	Alt. Mon.	8:00	Nov.-June	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
DETROIT	Detroit A. S.	2nd Sun.	3:00	Sept.-June	Wayne U., Rm. 187	E. R. Phelps, Wayne University
"	Northwest A.A.S.	1st, 3rd Tue.	8:00	Sept.-June	Redford High Sch.	A. J. Walrath, 14024 Archdale Ave.
DULUTH, MINN.	Duluth Ast. Club	1st, 3rd Sat.	8:00	All year	Darling Obs.	W. S. Telford, 126 N. 33rd Ave. E.
FT. WORTH	Tex. Observers	No regular meetings				Oscar E. Monnig, 1010 Morningside Dr.
GADSDEN, ALA.	Ala. A.A.	1st Thu.	7:30	All year	Ala. Power Audit.	Brent L. Harrell, 1176 *W* or 55
INDIANAPOLIS	Indiana A.A.	1st Sun.	2:00	All year	Central Library Audit.	E. W. Johnson, 808 Peoples Bank Bldg.
JOLIET, ILL.	Joliet A.S.	Alt. Tue.	8:00	Oct.-May	Jol. Mus. & Art Gall'y	Mrs. Robert L. Price, 403 Second Ave.
LOS ANGELES	L.A.A.S.	2nd Thu.	8:15	....	2606 W. 8th St.	Charles Ross, 2606 W. 8th St.
LOUISVILLE, KY.	L'ville A.S.	3rd Tue.	8:00	Sept.-May	Women's Bldg., Univ. of Louisville	Mary Eberhard, 3-102 Crescent Ct. *Taylor* 4157
MADISON, WIS.	Madison A.S.	2nd Wed.	8:00	All year	Washburn Obs.	C. M. Huffer, Univ. of Wisconsin
MILWAUKEE	Milw. A.S.	1st Thu.	8:00	Oct.-May	Marquette U., Eng. Col.	E. A. Halbach, *Hopkins* 4748
MOLINE, ILL.	Pop. Ast. Club	2nd Wed.	7:30	Oct.-April	Sky Ridge Obs.	Carl H. Gamble, Route 1
NEW HAVEN	New Haven A.A.S.	4th Sat.	8:00	Sept.-June	Yale Obs.	Milton T. Corbett, 47 Canner St.
NEW ORLEANS	A.S. of N. Orleans	Last Wed.	8:00	Sept.-May	Cunningham Obs. (Tulane Univ.)	Dr. J. Adair Lyon, 1210 Broadway
NEW YORK	A.A.A.	1st, 3rd Wed.	8:15	Oct.-May	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *EN.* 2-8500
" "	Junior Ast. Club	Alt. Sat.	8:00	Oct.-May	Amer. Mus. Nat. Hist.	J. B. Rothschild, Hayden Plan., *EN.* 2-8500
NORWALK, CONN.	Norwalk Ast. Soc.	Last Fri.	8:00	Sept.-June	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-4297
OAKLAND, CAL.	Eastbay A.A.	1st Sat.	8:00	Sept.-June	Chabot Obs.	Miss H. E. Neall, 6557 Whitney St.
PHILADELPHIA	A.A. of F.I.	3rd Fri.	8:00	All year	The Franklin Inst.	Edwin F. Bailey, *Rit.* 3050
"	Rittenhouse A.S.	2nd Fri.	8:00	Oct.-May	The Franklin Inst.	A. C. Schock, *Rit.* 3050
PITTSBURGH	A.A.A. of P'burgh	2nd Fri.	8:00	Sept.-June	Buhl Planetarium	Louis E. Bier, 402 Cedarhurst
PONTIAC, MICH.	Pontiac A.A.A.	2nd Mon.	8:00	All year	Private homes	John Setlow, Jr., 593 S. Paddock St.
PORTLAND, ME.	A.S. of Maine	2nd Fri.	8:00	All year	Private homes	H. M. Harris, 27 Victory Ave., S. Portland
PORTLAND, ORE.	Ast. Study Group	1st Mon.	8:00	All year	420-3 Av., Rm. 212	H. J. Carruthers, 427 S. 61 Ave.
PROVIDENCE, R. I.	Skyscrapers	1st Wed.	8:00	All year	Wilson Hall, Brown U.	Ladd Obs., Brown U., *GA.* 1633
READING, PA.	Reading-Berks A.C.	2nd Thu.	8:00	Sept.-June	Albright College	Mrs. F. P. Babb, 2708 Filbert Ave.
RENO, NEV.	A.S. of Nev.	4th Wed.	....	All year	Univ. of Nevada	G. B. Blair, University of Nevada
ROCHESTER, N. Y.	Roch. Ast. Club	Alt. Fri.	8:00	Oct.-May	Eastman Bldg., Univ. of Rochester	M. L. Groff, 400 University Ave.
SAN ANTONIO	San Ant. A.A.	3rd Mon.	8:00	All year	Le Villela	R. B. Poage, 807 Hammond Ave.
SCHENECTADY	S'tady Ast. Club	3rd Mon.	8:00	All year	Observatory site	C. H. Chapman, 216 Glen Ave., Scotia
SOUTH BEND, IND.	St. Joseph Val. Ast.	Last Tue.	8:00	All year	928 Oak St.	Fannie Mae Chupp, 224 Seebirt Pl.
STAMFORD, CONN.	Stamford Ast. Soc.	4th Wed.	8:00	Oct.-June	Stamford Museum	Stamford Mus., 300 Main St.
TACOMA, WASH.	Tacoma A.A.	1st Mon.	....	All year	Coll. of Puget Sound	Geo. Croston, *Gar.* 4124
TULSA, OKLA.	Tulsa A.S.	2nd Tue.	....	All year	Holland Hall	V. L. Jones, 4-8462
WASHINGTON, D.C.	Nat'l. Cap. A.A.A.	1st Sat.	8:00	Oct.-June	U. S. Nat'l. Museum	Stephen Nagy, 104 C St., N.E., *Linc.* 9487-J
WICHITA, KANS.	Wichita A.S.	2nd Tue.	8:00	All year	E. High Sch., Rm. 214	S. S. Whitehead, 2322 E. Douglas, 33148
YAKIMA, WASH.	Yak. Am. Astr'mers	2nd Tue.	7:30	All year	Y.M.C.A. Audit.	J. L. Thompson, 4 S. 10 Ave., 21455

★ ★

Planetarium Notes

Sky and Telescope is official bulletin of the Hayden Planetarium in New York City and of the Buhl Planetarium in Pittsburgh, Pa.

★ THE BUHL PLANETARIUM presents in *July*, BY ROCKET TO THE MOON.

Have you not longed at some time to journey to the nearest of the heavenly bodies, the beautiful but mysterious little moon, and see its wonders? Here's your chance, as the Buhl Planetarium offers interplanetary rocket service this month in the 21st century. We find ourselves in a luxurious space liner which whisks us to the moon in a few thrill-crowded minutes. Before landing, we explore the moon's mountainous surface and study at close range the strange craters and seas, the weird and colorful scenery. While we are landed on the floor of a lunar crater, many adventures befall us. We see our own earth hanging in the sky amongst the stars—see it eclipse the sun as we suddenly are plunged into the earth's red shadow. At length our rocket turns about and carries us home.

★ THE HAYDEN PLANETARIUM presents in *July*, SUMMER STARS. (See page 8.)

In *August*, THE ANSWER'S IN THE SKY. What time is it? How do we know the date? What causes the seasons—the midnight sun? These and other questions are propounded by mail, telephone, and by planetarium visitors. This month we shall show the audiences that in many cases the answer's in the sky.

★ SCHEDULE BUHL PLANETARIUM

Mondays through Saturdays (except Tuesdays)........3 and 8:30 p.m.
Sundays and Holidays..3, 4, and 8:30 p.m.
(Building closed Tuesdays)

★ STAFF—*Director*, Arthur L. Draper; *Lecturer*, Nicholas E. Wagman; *Manager*, Frank S. McGary; *Public Relations*, Robert F. Hostetter; *Chief Instructor of Navigation*, Fitz-Hugh Marshall, Jr., *Instructor, School of Navigation*, Edwin Ebbighausen.

★ SCHEDULE HAYDEN PLANETARIUM

Mondays through Fridays..................................2, 3:30, and 8:30 p.m.
Saturdays ....11 a.m., 2, 3, 4, 5, and 8:30 p.m.
Sundays and Holidays.....................................2, 3, 4, 5, and 8:30 p.m.

★ STAFF—*Honorary Curator*, Clyde Fisher; *Curator*, William H. Barton, Jr.; *Associate Curator*, Marian Lockwood; *Assistant Curator*, Robert R. Coles (on leave in Army Air Corps); *Scientific Assistant*, Fred Raiser; *Lecturers*, Charles O. Roth, Jr., Shirley I. Gale, John Saunders.